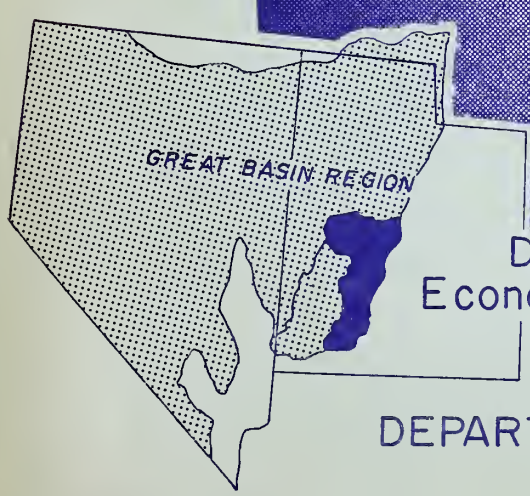
SEVIER RIVER BASIN
UTAH

EARLY ACTION PROGRAM



Prepared by
UNITED STATES
DEPARTMENT of AGRICULTURE
Economic Research Service-Forest Service
Soil Conservation Service
In cooperation with
DEPARTMENT of NATURAL RESOURCES
STATE of UTAH

EARLY ACTION PROGRAM

SEVIER RIVER BASIN, UTAH

United States Department of Agriculture
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Department of Natural Resources
State of Utah

August 1970

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CHAPTER I

SUMMARY

OBJECTIVE AND SCOPE

The purpose of this report is to present information on the opportunities for coordinated development of the water and related land resources of the Sevier River Basin. Development would facilitate better utilization of the resources, increase income levels of inhabitants and environmental conditions. This development program is called an Early Action Program.

Available water supplies limit the development potential. However, there are many opportunities for improved management and use of available water resources. Large scale development of this resource has not been possible in the past because of the close hydrologic interrelationships. Water is diverted to croplands, travels through the soil profile and eventually returns as surface flow in the river where it is again available for rediversion. About 40 percent of the irrigation supply is dependent upon this reuse of water. Because of this interrelationship, management changes in one area affect hydrologic conditions downstream. Since the magnitude of these changes is usually unknown, any change in the status-quo is vigorously opposed. Development is possible where changes in outflow from each hydrologic unit can be compensated for by other developments.

Information from a wide range of sources was utilized in preparing this program. Limited field studies were made and only one development alternative was evaluated in depth. There can be an infinite number of alternatives by varying the intensity of individual practices and combining practices into a total Basin program. Chapter IV, "Alternatives and Long Range Development," sets the Basin-wide framework by evaluating the total potential for development as it relates to future needs. Chapter III describes the Early Action evaluation alternative as a program that could achieve coordinated development. This program is one example of the type of development possible and it is realized that any program must be developed by local people and be based on detailed field investigation before final plans can be formulated.

WATER RESOURCE DEVELOPMENT OPPORTUNITIES

Multiple-purpose reservoirs are suggested which could provide 27,000 acre-feet of sediment storage, 11,400 acre-feet of flood control, 17,600 acre-feet of irrigation water storage and 380 surface acres for recreation use. Other structural measures include 380 miles of canal lining, 70 miles of pipelines and salvage of 97,000 acre feet of groundwater. There is an additional 632,000 acre-feet of groundwater available for management. Some measures investigated may not be feasible or desirable when more detailed studies are made.

The total increased outflow from the Basin is about 14,400 acre-feet including 3,900 acre-feet outflow to the Fillmore area through the Central Utah Canal. The present outflow is about 13,700 acre-feet to Sevier Lake and about 5,200 acre-feet to the Fillmore area.

RELATED LAND DEVELOPMENT

Watershed stabilization, range improvement, and recreation developments are planned to meet environmental, social and economic objectives. The work planned on public lands is authorized under existing authorities of land managing agencies, but additional funds are needed to accelerate these programs.

Watershed stabilization is planned on about 358,000 acres as well as many miles of roads, streams, and gullies. Lands to be treated include National Forests, Public Domain and private lands. Benefits include retaining annually about 890 acre-feet of soil in place to maintain the productivity of the land, preserve aesthetic values, and improve water quality downstream. Improved productivity will provide about 72,500 animal unit months annually of additional grazing by domestic livestock and wildlife.

Improved forage production will result on about 396,000 acres of National Forest, Public Domain and private lands as part of the range development program. Development of livestock water and fencing are an integral part of the range improvement program. Increased forage for an additional 86,800 animal unit months annually of livestock grazing will result as well as erosion being reduced annually by an additional 430 acre-feet.

RECREATION DEVELOPMENT

Recreation development is planned to accomodate water-oriented recreation demand by 1985. Projected demand includes 229,000 additional visitor-days of fishing and 36,800 visitor-days of

boating use. Of this demand, 116,000 visitor-days of water-oriented recreation were claimed as benefits for project measures. In addition, campground and picnic area development was evaluated to provide 337,000 visitor-days. Additional development that should be considered concurrently with the Early Action Program are better access through improved roads and trails, boating and sanitation facilities at existing and proposed reservoirs, protection of historical and archaeological sites, observation sites and other facilities.

ON-FARM DEVELOPMENT

Accelerated on-farm developments include conversion of 29,700 acres of wetlands to irrigated cropland, 47,200 acres of land leveling and sprinkler irrigation, and 400 miles of ditch lining and pipelines. These practices along with those applied under the going programs will increase the Basin irrigation efficiency about 4 percent. To accomplish this, 2,440 conservation plans will be required in addition to those completed at the current rate.

COSTS AND BENEFITS

The total cost of all elements of the Early Action Program is $56,093,620. Annual cost is $4,257,100 with annual benefits of $8,238,330. The total costs are:

	Federal	Non-Federal	Total
Structural measures	14,717,200	12,712,770	27,429,970
Erosion control	9,601,800	110,000	9,711,800
Range improvement	5,048,550	214,900	5,263,450
Recreation[a]	5,163,400	0	5,163,400
On-farm land treatment	4,436,000	4,089,000	8,525,000
	38,966,950	17,126,670	56,093,620

[a]Does not include costs related to structural measures. These are included in cost of structural measures.

CHAPTER II

INTRODUCTION

Water and related land resource development opportunities are presented to help meet social and economic objectives; this is called an Early Action Program. The term "Early Action" is used to describe a proposed basin-wide program to develop water and related land resources within a ten to fifteen year period. Hopefully, this program will stimulate new interest in coordinated resource development.

PURPOSE AND OBJECTIVES

The people residing in the Sevier River Basin can increase their income level and the quality of their environment through an Early Action Program. The income level of people in the Sevier River Basin is significantly below State and National averages. Some natural resources are deteriorating while at the same time others are not being used to full potential. Large scale development has been prevented because hydrologic interrelationships and management patterns make it difficult to develop water resources on a small area basis without affecting water use and management patterns in other areas.

This report is based on the document "Water and Related Land Resources, Sevier River Basin, Utah," and related appendices. The summary report presents a description of the Basin in terms of its resources, economy, problems, and potential along with existing U.S. Department of Agriculture programs and opportunities for development.

This report presents the opportunities for basin-wide development of water and related land resources. Its purpose is to present these opportunities as a basis or framework for local planning and to present alternatives for local decisions. No attempt has been made to prejudge the desirability of any part or aspect of the presented program on a local basis. Therefore, it is emphasized that this is not a recommended plan but a presentation of opportunities to unify the people of the Sevier River Basin in a common objective, beneficial to all.

Overall objectives of the Early Action Program are improved income levels, better use of the resources and improving the environment. Specifically, there are opportunities to achieve

these objectives by (1) Reducing erosion and sedimentation, (2) alleviating flood problems within municipal and agricultural areas and reducing damage in other areas, (3) improving water quality, (4) eliminating water shortages on presently irrigated lands, (5) reducing consumptive use of water by low-value phreatophytes, (6) improving fish and wildlife habitat, (7) increasing domestic livestock grazing capacities, and (8) providing additional outdoor recreation opportunities.

DESCRIPTION OF BASIN

LOCATION

The Sevier River Basin is a major landlocked drainage within the Great Basin located in south-central Utah. It covers 5,200,000 acres and includes portions of Garfield, Iron, Juab, Kane, Millard, Piute, Sanpete, Sevier and Tooele counties (Map 1).

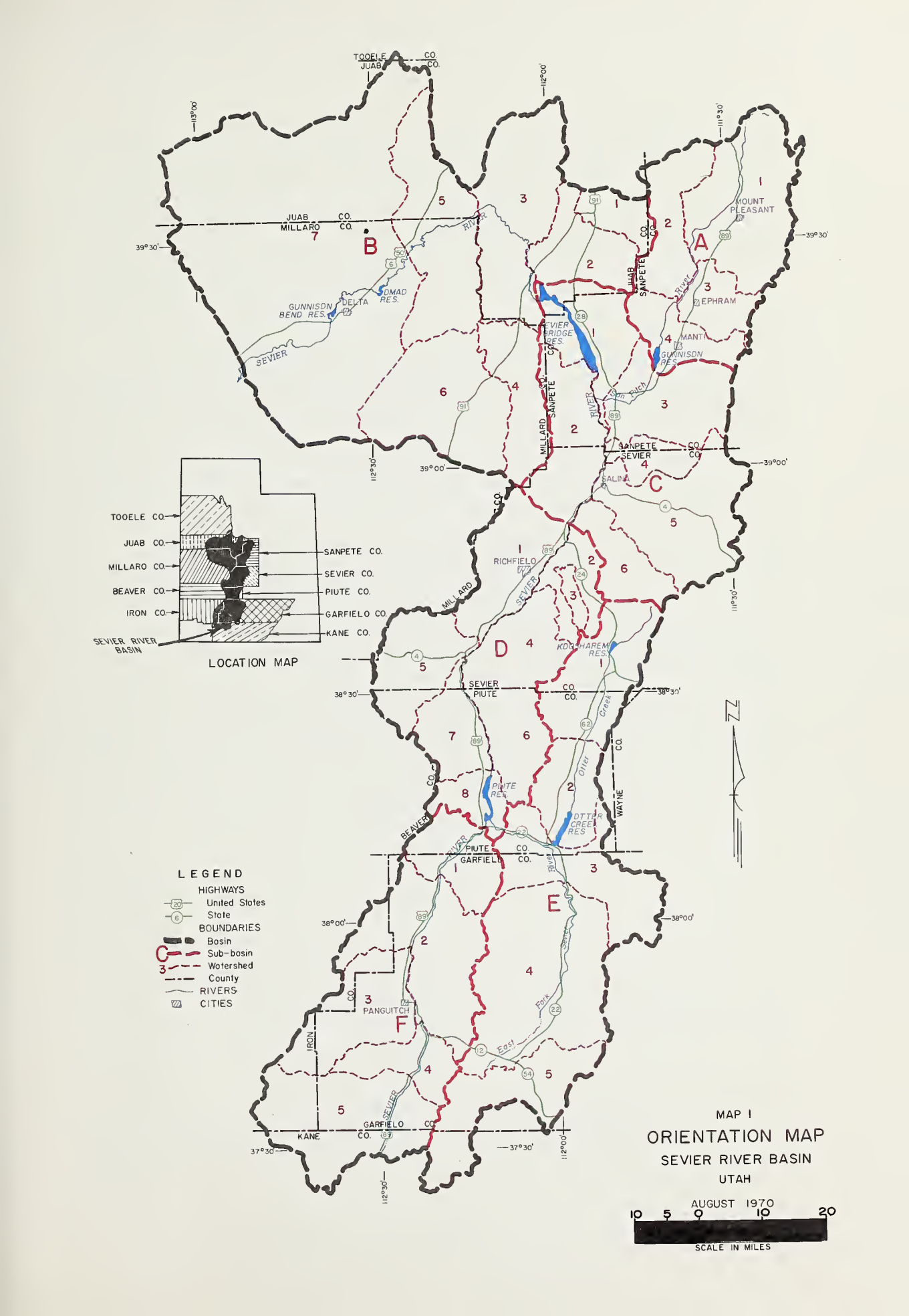
The Basin is bounded on the east and south by the Colorado River Basin, on the west by the Beaver River Basin, and on the north by the Great Salt Lake Basin. The Sevier River once discharged into prehistoric Lake Bonneville and now terminates in Sevier Lake playa.

Mountain ranges trend in a southwesterly-northeasterly direction with long and narrow valleys except where the river flows into the Sevier Desert. Elevations range from 4,500 to 12,173 feet.

WATER AND RELATED LAND RESOURCES

Water has many uses and benefits. One of the primary benefits is to maintain valley and mountain vegetation. This vegetation, in addition to its aesthetic qualities, provides protection to the soil mantle, income from crop production, forage for livestock and habitat for wildlife. Municipal, domestic, industrial and livestock water uses are small but important. Non-consumptive water uses include recreation and aesthetics of lakes and streams as well as fish, waterfowl and other wildlife habitat.

The availability of water is usually the limiting resource in development. The total water resource (total precipitation) is about 6.5 million acre-feet. About 5.4 million acre-feet are consumptively used on-site by forest and rangeland vegetation or lost through evaporation.


TOOELE CO.
JUAB CO.
MILLARD CO.
BEAVER CO.
IRON CO.
SANPETE CO.
SEVIER CO.
PIUTE CO.
GARFIELD CO.
KANE CO.
SEVIER RIVER BASIN
LOCATION MAP
LEGEND
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United States
State
BOUNDARIES
Basin
Sub-basin
Watershed
County
RIVERS
CITIES
MOUNT PLEASANT
EPHRAM
MANTI
GUNNISON RES.
GUNNISON BEND RES.
DELTA
OMAD RES.
SEVIER BRIDGE RES.
SALINA
RICHFIELD
KOOSHAREM RES.
PIUTE RES.
OTTER CREEK RES.
PANGUITCH
MAP I
ORIENTATION MAP
SEVIER RIVER BASIN
UTAH
AUGUST 1970
10 5 0 10 20
SCALE IN MILES

The amount of water available for crop production after diversions out of the Basin is about 1,103,600 acre-feet; 706,000 acre-feet as tributary stream and groundwater inflow and 398,000 acre-feet as precipitation falling directly on cropland areas. This resource is presently used as follows: (1) Irrigated rotation cropland, 511,000 acre-feet, (2) irrigated wet meadows and pastures, 53,900 acre-feet, (3) nonirrigated wet meadows and pastures, 263,000 acre-feet, (4) low-value phreatophyte areas, 159,000 acre-feet, (5) evaporation from water surface areas, 108,000 acre-feet, and (6) domestic uses, 8,700 acre-feet.

The principal land use is for agriculture and along the river and major tributary stream valleys, the primary use is for crop production. These valley lands, together with the associated wetlands and water surfaces, comprise the water-budget area of 640,000 acres or about 10 percent of the Basin. About 48 percent of the water-budget area lands are irrigated, 20 percent are wetlands, 20 percent are other less beneficial phreatophytes, and 12 percent are water surfaces, bare ground and dry cropland.

There are about 250,000 acres of irrigable land not now cultivated mainly because of insufficient water supplies. Of this total, 70,000 acres lie below established irrigation systems.

Less intensively developed areas surrounding the farm lands comprise 4,700,000 acres or 90 percent of the Basin. These lands presently produce forage for 611,000 animal unit months of grazing for sheep and cattle. These lands also provide habitat for a variety of wildlife. Commercial forest grows on 520,000 acres and produces an annual harvest of sawtimber of about 26 million board feet as well as other forest products. Recreation use in 1965 was 1,705,000 visitor-days. These forests and rangelands yield the tributary inflow to the cropland area as well as being a principle source of groundwater recharge.

PROBLEMS

Heavy to excessive erosion is a problem on 20 percent of the area. Critical areas are eroding on-site at a rate of 4,300 acre-feet annually and produce sediment downstream at a rate of about 860 acre-feet annually. During the 1890 to 1968 period, 439 floods were caused by rapid runoff from critical areas. Related problems include reduced productivity of the land, fish habitat damage, and an adverse affect on the environment.

Reductions in livestock grazing on public lands have caused economic problems. Declining forage yield on rangelands and related watershed problems have resulted in the need for these reductions.

Suspended sediment, dissolved solids, and bacteriological and chemical contamination are all serious problems, especially in the main stem of the Sevier River. Recreation, irrigation, domestic, industrial, aesthetic, and fish and wildlife are present and future uses that will require quality protection and improvement.

Water pollution cannot be entirely controlled. Opportunities for reducing quantities of dissolved solids are partly limited by areas of Arapien shale which contribute large quantities of salt to the river system.

Irrigation water shortages have resulted in economic losses to local people. During a year of average water supply, shortages are 78,000 acre-feet at the crop root zone.

Phreatophytes use about 285,000 acre-feet of groundwater annually. However, wet meadows and native pastures, which constitute 54 percent of this area, are valuable for forage production. The other phreatophytes, while not profitable for forage production, provide food and cover for wildlife.

Lack of livestock water in many areas limits animal distribution and prevents efficient use of available forage on rangeland. Also, the widespread practice of distributing winter livestock water through irrigation systems damages canal linings and is an inefficient use of water.

Domestic water supplies are inadequate in some communities at times during the summer. Over 50 percent of the public water supply systems do not meet standards established by the Utah State Division of Health.

Recreational demands are expected to increase from 1,705,000 visitor-days in 1965 to 4,695,000 visitor-days by 1985. This will require additional development with special emphasis on aesthetic suitability and accessibility of land and water resources for recreational uses. The control and management of wildlife resources will be influenced by increased population and recreational activities.

HYDROLOGIC INTERRELATIONSHIPS

The Sevier River is one of the most completely consumed river systems in the United States. Only about 1 percent or 13,690 acre-feet of the total water supply available for crop production terminates in Sevier Lake, primarily as groundwater and drainage outflow. About 40 percent of the total diversions depend on return flow from irrigation upstream to satisfy this need. Water rights are established and based on this reuse of water allowing

dry diversion dams at numerous points along the river system. This creates a situation where any change in the quantity, time or place of use has an impact downstream.

The surface water and groundwater are inseparably connected so that changes in the use pattern of one has a direct affect on the other. Above Sevier Bridge Reservoir, groundwater is impounded in nine major underground reservoirs, each contained by a geologic dam. Present irrigation water use from this source is relatively insignificant. Thus, groundwater reservoirs remain filled and water moving into the basin recharges downstream surface flows. Because of this interrelationship, use and management of groundwater has not been a general practice. However, the water users have developed a system of management and regulation of the surface water administered under the "Cox Decree" which adjudicates use of water.

ECONOMIC CHARACTERISTICS AND PROJECTIONS

POPULATION

The population of the Sevier River Basin has declined since 1920 when it was at an all-time high. In 1920, the population was 42,043 compared to 31,085 in 1960. The largest decreases have occurred since 1950, 3 percent from 1940 to 1950 and 17 percent from 1950 to 1960 (Table 1).

The population will continue to be influenced by the dominance of agriculture and related industries. Nevertheless, the number of people directly engaged in agriculture will continue to decline as past trends toward larger and more efficient farms continue.

The population is expected to stabilize during the 1970-80 period. Reduced employment in agriculture will be offset by increases in recreational activities and small labor-oriented industries.

EMPLOYMENT

Total employment reached a peak of 11,560 in 1950 and then decreased to 10,170 in 1960. The trend of decreasing employment is expected to change by 1980 and then increase through 2020. Agricultural employment decreased from 4,280 in 1950 to 2,655 in 1960 (Table 2). This trend is expected to continue in the future. Manufacturing and service sectors are projected to provide increased employment opportunities with many of the new job opportunities filled by part-time farmers.

TABLE 1.--Past and projected population of Sevier River Basin and State of Utah, 1890-2020

Year	Sevier River Basin[a]	Utah	Basin portion of State
	Number	Number	Percent
1890	26,955	207,095	12.97
1900	33,636	276,749	12.15
1910	35,657	373,351	9.55
1920	42,043	449,396	9.36
1930	39,667	507,847	7.81
1940	40,909	550,310	7.43
1950	37,426	688,862	5.43
1960	31,085	890,627	3.49
1970	29,660	1,134,600	2.61
1980	30,720	1,446,800	2.12
2000	33,460	2,050,000	1.63
2020	35,760	2,675,000	1.34

[a]County population figures adjusted to reflect Sevier River Basin boundaries.

Source: U.S. Census of Population, unpublished data provided by Bureau of Economic and Business Research, College of Business, University of Utah, and 1969 OBERS projections for Sevier Subregion of the Great Basin water resource area.

TABLE 2.--Past and projected employment by sector for Sevier River Basin, selected years, 1940-2020

Year	Agriculture and forestry	Mining	Manufacturing	Other	Total
1940	4,150	525	320	4,400	9,395
1950	4,280	545	710	6,025	11,560
1960	2,655	470	825	6,220	10,170
1970	1,940	315	945	6,090	9,290
1980	1,650	300	1,150	6,455	9,555
2000	1,260	280	1,540	7,220	10,300
2020	900	255	2,010	7,655	10,820

Source: OBERS water resource planning projections adjusted to fit Sevier River Basin area.

INCOME

Per capita income increased from $749 in 1940 to $1,454 in 1959 and is projected to be $9,556 by 2020. Comparable figures for the United States shows $1,296 in 1940, $2,134 in 1959 and $12,411 by 2020 (Table 3).

TABLE 3.--Past and projected per capita income, Sevier River Basin, Great Basin and United States, selected years, 1940-2020

Year	Per capita income		
	Sevier River Basin	Great Basin Region	United States
	Dollars	Dollars	Dollars
1940	749	1,236	1,296
1950	1,253	1,745	1,805
1959	1,454	2,051	2,134
1970	2,099	2,960	3,046
1980	2,868	4,000	4,112
1990	3,790	5,230	5,346
2000	5,151	7,065	7,161
2010	7,035	9,375	9,467
2020	9,556	12,323	12,411

Source: OBERS water resource planning projections, March 1969

When compared to the United States, the area will have a 1970 per capita income deficit of $947 which will increase without Early Action development to $2,855 by 2020. These figures are in terms of real dollars and reflect rising productivity of workers and industry.

Earnings per worker have always been below the Great Basin and United States levels. Earnings per worker were $2,822 in 1940, $3,629 in 1959 and are projected to be $6,742 in 1980 (Table 4). These figures show over a $1,000 deficit for workers in the Sevier River Basin compared with the Great Basin Region and the United States. However, this deficit is not as large as the per capita income deficit because the workers participation ratio is lower in the Sevier River Basin than other areas.

Total personal income increased from $30.7 million in 1940 to $44.1 million in 1959 and will continue increasing to an expected level of $341.5 million in 2020. Projections indicate that the people within the area will improve their relative position with respect to per capita income deficits when compared to other areas (Table 5).

TABLE 4.--Past and projected earnings per worker, Sevier River Basin, Great Basin and United States, selected years, 1940-2020

Year	Earnings per worker		
	Sevier River Basin	Great Basin Region	United States
	Dollars	Dollars	Dollars
1940	2,822	3,566	3,070
1950	3,460	4,225	3,935
1959	3,629	4,697	4,685
1970	5,098	6,424	6,310
1980	6,742	8,187	8,080
1990	8,951	10,517	10,391
2000	12,068	13,811	13,617
2010	16,236	18,067	17,831
2020	21,809	23,638	23,362

Source: OBERS water resource planning projections, March 1969.

TABLE 5.--Past and projected total personal income for Sevier River Basin and relative per capita income position to Great Basin and United States, selected years, 1940-2020

Year	Sevier River Basin personal income[a]	Relative per capita income position to United States (US=100)	
		Sevier River Basin	Great Basin Region
	Thousand dollars	Percent	Percent
1940	30,725	58	95
1950	47,390	69	97
1959	44,145	68	96
1970	62,285	69	97
1980	88,170	70	97
1990	120,813	71	98
2000	172,360	72	99
2010	243,400	74	99
2020	341,540	77	99

[a]OBERS personal income projections for the Sevier Subregion were adjusted to reflect the Sevier River Basin area.

Source: OBERS water resource planning projections, March 1969.

AGRICULTURAL PRODUCTION

Projected agricultural needs for categories of food, fiber and livestock products are shown in Table 6. Projections show increased needs for all products in 1980, 2000 and 2020. These projections were interpreted from OBERS national planning projections to reflect the Sevier River Basin's share of the national needs for food and fiber.

TABLE 6.--Projected demand for selected agricultural products, Sevier River Basin, 1980, 2000 and 2020

Item	Unit	Year			
		1959-61	1980	2000	2020
Crop					
Corn for grain	Bushel	6,425	6,750	7,970	8,865
Oats	Bushel	158,800	166,738	196,910	219,140
Barley	Bushel	1,369,410	1,437,840	1,619,760	2,030,020
Hay	Ton	354,995	372,745	440,195	489,895
Corn silage	Ton	77,665	81,545	96,390	107,175
Alfalfa seed	Cwt.	40,590	42,620	50,330	56,010
Wheat	Bushel	479,000	651,740	723,690	847,850
Sugar beets	Ton	32,545	52,570	81,780	118,500
Potatoes	Cwt.	514,890	766,905	974,500	1,323,520
Pasture	AUM	600,000	632,550	776,085	851,190
Livestock Products					
Beef and veal	1,000 lbs. liveweight	41,460	74,800	99,760	131,355
Lamb and mutton	1,000 lbs. liveweight	14,430	17,660	23,410	30,690
Pork	1,000 lbs. liveweight	2,640	2,860	3,735	4,830
Milk	1,000 lbs.	88,964	101,990	132,860	171,515
Eggs	1,000 eggs	15,470	24,530	32,180	41,840
Turkeys	1,000 lbs. liveweight	30,790	66,625	86,860	112,140

Source: OBERS water resource planning projections adjusted to fit Sevier River Basin area.

Within the framework of these needs and the technological changes expected in the Basin's agriculture, the fully irrigated harvested cropland needed to meet future national demand for food and fiber are as follows:

Base year 1964	278,000 acres
1980	220,000 acres
2000	224,000 acres
2020	226,000 acres

These figures indicate the number of fully irrigated harvested acres of cropland required to meet the demand using the average projected yields shown in Table 7. The data collected and used in this report reflect a long-term average situation which includes variations in water supply, temporarily idle land, and fallow land. Accordingly, the Sevier River Basin summary report shows 378,000 of croplands and the present acreages used for projections are shown as 278,000 acres. Some differences also exist due to hydrologic and economic region boundaries and sources of data used.

TABLE 7.--Projected average crop yields, Sevier River Basin, selected years, 1965-2020

Crop	Unit	Production per acre			
		Base year 1965	1980	2000	2020
Alfalfa hay	Ton	3.0	3.6	4.2	4.8
Other tame hay	Ton	2.0	2.4	2.8	3.2
Wild hay	Ton	1.6	1.9	2.2	2.6
Corn silage	Ton	15.0	18.5	23.0	27.0
Barley	Bu.	58.0	70.0	91.0	107.0
Wheat	Bu.	32.0	52.0	64.0	72.0
Potatoes	Cwt.	160.0	216.0	274.0	330.0
Sugar beets	Ton	14.3	16.0	17.6	17.6
Dryland wheat	Bu.	21.0	24.0	28.0	30.0

Source: OBERS water resource planning projections, March 1969

CHAPTER III

RESOURCE DEVELOPMENT EARLY ACTION PROGRAM

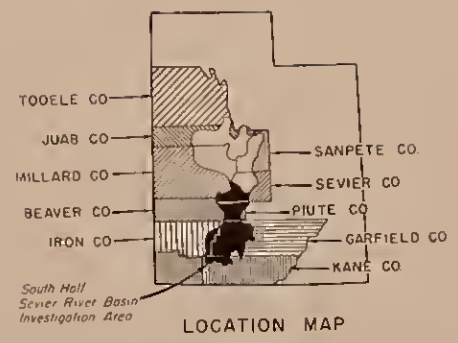
The Early Action Program identifies development opportunities to solve many of the water and related land resource problems. However, most of these solutions are only possible through basin-wide coordinated development because of the hydrologic interrelationships involved. Basin-wide development is dependent upon local acceptance and support of a comprehensive program. New authority is needed for U.S. Department of Agriculture to assist in such a development program and administration of the program must rest with a local sponsoring organization responsive to local needs and having local support.

This chapter is an example of the type of development program that could be requested for authorization. However, the program discussed in this chapter is but one alternative, found economically feasible at this level of investigation. Identification of individual components of the program which include watershed stabilization, water resource development structures, on-farm land treatment, range development and recreation development does not imply that they are either feasible or desirable for installation at this time. This determination must be based upon intensive study and evaluation, coordination with other resources and uses, hydrologic interrelationships, and the desires of the local people. For this reason, alternate developments are also shown so that the local people can have advantage of all available information in making the best choice to fulfill their desires and needs. This will also require an understanding of the hydrologic interrelationships inherent in the Sevier River system. Map 2 shows the cultural features, drainage patterns, and the hydrologic sub-basin and watershed units which are referred to frequently throughout the report. Figure 1 shows a schematic of the interrelationtionships of resource developments (Page 87).

WATERSHED STABILIZATION AND IMPROVEMENT

There are interrelationships between land and water and the effects of land treatment upon the nature and quality of streamflow. Water that flows from the mountains is the residual of precipitation not used through evapotranspiration by vegetation or evaporation from soil and snow surfaces. The characteristics of this runoff is determined by watershed conditions.

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE — USDA-SCS-PORTLAND, OREG. 1969



LOCATION MAP

LEGEND

Annual yield in inches

Water budget area boundary

Note: The yield measured from this map was adjusted by the following percentages in order to balance the water budget

D-1—68	E-1—93	F-1—100
D2&3—168	E-2—72	F-2—68
D-4—70	E-3—67	F-3—57
D-5—100	E-4—91	F-4—68
D687—87	E-5A—129	F-5—89
D-8—185	E-5B—130	

Source: Adopted from Forest Service yield map

ANNUAL YIELD
AND
WATER BUDGET AREA MAP

MAP 8

WATER BUDGET AREA AND YIELD MAP

SOUTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

SOUTH HALF M7-R-21058-N

LEGEND

HIGHWAYS -
- Interstate (Proposed)
- United States
- State

BOUNDARIES
- Counties
- National Forests, Monuments and Parks
- Basin & Sub-basin
- Watershed

LOCATION MAP

MAP 2

LOCATION MAP

NORTH HALF

SEVIER RIVER BASIN

UTAH

FEBRUARY 1969

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE USDA-SCS-PORTLAND, OREG. 1969

NORTH HALF M7-R-18935-N

Problem areas are designated as "critical areas" and are principle sources of silt and sediment. The extent of these areas is indicated for each sub-basin. The amount of sediment yield and sediment yield reduction through watershed stabilization and improvement are also estimated.

Watershed stabilization measures directly influence planning of downstream structures. These measures are also interrelated with the benefits of improved water quality and reduced peak flood flows to existing downstream structures.

On-site benefits include reduced erosion, improved wildlife habitat, and a reduction in peak flood flows. Social and economic benefits are related to environmental quality, employment opportunities, and economic stimulus to the area.

Vegetation improvement is one way to improve hydrologic conditions of watersheds. Improvement practices include proper livestock management and removing less desirable vegetation such as pinyon-juniper or sagebrush and establishing grasses or other plants that will protect the soil. Common practices include chaining of pinyon-juniper or sagebrush, herbacide treatment of sagebrush, and plowing or other mechanical means to reduce competition from less desirable species. Grass species and browse for wildlife are planted following treatment.

On steep slopes where rapid surface runoff is accelerating erosion, contour trenching or furrowing has been successful in conjunction with vegetation improvement.

Improperly located and poorly drained roads and trails are principle sources of sediment. Stabilization measures include installing proper drainage and stabilizing the soil on cut and fill slopes. Some roads and sheep driveways are poorly located or infrequently traveled and should be closed and obliterated.

Channel stabilization in both perennial and intermittent streams includes removing water from existing drainage channels and protecting streambanks to reduce erosion. The more expensive measures were planned only where resource values were commensurate with the additional expense. Some measures employed are: Small brush check dams, gully plugs, sloping and vegetating vertical banks, willow planting, gabion or log deflectors and water-spreading structures. Drop structures are used to reduce erosion from head cutting, to dissipate the hydrologic head, and reduce the erosive force of a stream.

Protection fences prevent damage to watershed stabilization measures. Livestock management fences are not included in this category.

SUB-BASIN F (South Fork)

In Sub-basin F, critical areas include 102,500 acres on National Forests, 30,000 acres on Public Domain and 15,500 acres on private land. Critical areas by watershed are as follows:

Watershed F1 - 31,100 acres
Watershed F2 - 60,700 acres
Watershed F3 - 20,700 acres
Watershed F4 - 23,700 acres
Watershed F5 - 11,800 acres

Sub-basin F - 148,000 acres

Critical Area Treatment

Under the Early Action evaluation alternative, 88 percent of the critical area on National Forest lands, 50 percent on Public Domain lands and 25 percent on private lands was evaluated for treatment. Opportunities evaluated are shown in Table 8. Benefits and costs for critical area treatment is shown in Table 9.

Interrelationships

Treatment in Sub-basin F should have on-site and downstream effects as indicated by Table 10. Sediment reduction could influence water quality and design capacities of structures, both within this sub-basin and downstream. Improved water quality in this sub-basin is important due to present and anticipated recreational demands. The net effect of treatment evaluated is an annual reduction of 58 acre-feet of sediment.

SUB-BASIN E (East Fork)

In Sub-basin E, critical watershed areas include 161,770 acres on National Forests, 46,000 acres on Public Domain and 5,440 acres on private land. Critical areas by watershed are as follows:

Watershed E1 - 12,790 acres
Watershed E2 - 29,850 acres
Watershed E3 - 36,250 acres
Watershed E4 - 81,020 acres
Watershed E5 - 53,300 acres

Sub-basin E - 213,210 acres

TABLE 8.--Watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin F, Early Action Program, Sevier River Basin

	Contour trench or furrow and seed	Vegetation improvement	Channel stabilization	Drop structures	Road and trail stabilization	Protection fence	Detention dams
	Acres	Acres	Miles	Each	Miles	Miles	Each
National Forest	21,500	69,300	68	155	290	72	0
Public Domain	0	15,000	23	0	5	22	15
Private lands	0	3,860	3	0	0	0	6

TABLE 9.--Benefits and costs for watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin F, Early Action Program, Sevier River Basin

Annual benefits	National Forest	Public Domain	Private lands	Total
	Dollars	Dollars	Dollars	Dollars
Erosion and sediment control[a]	100,500	18,500	5,000	124,000
Grazing benefits	67,900	10,100	4,300	82,300
Redevelopment benefits	41,700	6,200	1,400	49,300
Secondary benefits	25,300	4,200	1,300	30,800
Total annual benefits	235,400	39,000	12,000	286,400
Annual costs				
Total installation costs	2,508,000	312,600	78,700	2,899,300
Amortization of installation costs[b]	129,400	16,100	4,100	149,600
Replacement, operation and maintenance	17,000	3,100	790	20,890
Total annual costs	146,400	19,200	4,890	170,490
Benefit-cost ratio	1.6:1	2.0:1	2.5:1	1.7:1

[a]Estimated at $500 per acre-foot.

[b]100 years at 5 1/8 percent interest.

Critical Area Treatment

Under the Early Action evaluation alternative, 43 percent of the critical area on National Forest lands, 11 percent on Public Domain lands and 25 percent on private lands were evaluated for treatment. Opportunities evaluated are shown in Table 11. Benefits and costs for critical area treatment is shown in Table 12.

Interrelationships

Treatment in Sub-basin E should have on-site and downstream effects as indicated by Table 13. Sediment reduction could influence water quality and design capacities of structures, both within this sub-basin and downstream. The net effect at the level of treatment evaluated is an annual reduction of 36 acre-feet of sediment.

SUB-BASIN D (Upper Sevier)

In Sub-basin D, critical watershed areas include 194,780 acres on National Forests and 100,000 on Public Domain. Critical areas by watershed are as follows:

Watershed D1 - 35,370 acres	Watershed D5 - 73,690 acres
Watershed D2 - 29,480 acres	Watershed D6 - 58,960 acres
Watershed D3 - 5,900 acres	Watershed D7 - 26,530 acres
Watershed D4 - 53,060 acres	Watershed D8 - 11,790 acres
	Sub-basin D - 294,780 acres

Critical Area Treatment

Under the Early Action evaluation alternative, 16 percent of the critical area on National Forest lands and 10 percent on Public Domain lands was evaluated for treatment. Opportunities evaluated are shown in Table 14. Benefits and costs for critical area treatment is shown in Table 15.

Interrelationships

Treatment in Sub-basin D should have on-site and downstream effects as indicated by Table 16. Sediment reduction could influence water quality and design capacities of structures, both within this sub-basin and downstream. The net effect at the level of treatment evaluated is an annual reduction of 22 acre-feet of sediment.

TABLE 10.--Annual sediment yield reduction and increased grazing capacity resulting from watershed stabilization on critical areas, Sub-basin F, Early Action Program, Sevier River Basin

Item	Unit	National Forest	Public Domain	Private lands	Total
Existing on-site erosion	acre-feet	467	137	70	674
Existing sediment yield[a]	acre-feet	93	27	14	134
Reduction in sediment yield through treatment	acre-feet	40	14	4	58
On-site erosion reduction through treatment	acre-feet	201	37	10	248
Increased forage productivity reflected by increased grazing capacity	animal unit month	13,860	3,360	3,110	20,330

[a]Based on 1:5 ratio to erosion

TABLE 11.--Watershed stabilization opportunities on National Forest, Public Domain and private lands Sub-basin E, Early Action Program, Sevier River Basin

	Contour trench or furrow and seed	Vegetation improvement	Channel stabilization	Drop structures	Road and trail stabilization	Protection fence	Detention dams
	Acres	Acres	Miles	Each	Miles	Miles	Each
National Forest	7,800	61,800	101	128	277	20	0
Public Domain	0	5,000	5	0	5	15	21
Private lands	0	1,360	0	0	0	0	3

Base year 1965.

TABLE 12.--Benefits and costs for watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin E, Early Action Program, Sevier River Basin

Annual benefits	National Forest	Public Domain	Private lands	Total
	Dollars	Dollars	Dollars	Dollars
Erosion and sediment control[a]	77,500	6,000	1,500	85,000
Grazing benefits	60,600	2,800	1,200	64,600
Redevelopment benefits	29,300	4,400	550	34,250
Secondary benefits	20,300	1,300	430	22,030
Total annual benefits	187,700	14,500	3,680	205,880
Annual costs				
Total installation costs	1,763,000	221,100	30,800	2,014,900
Amortization of installation costs[b]	91,000	11,400	1,600	104,000
Replacement, operation and maintenance	11,900	2,200	310	14,410
Total annual costs	102,900	13,600	1,910	118,410
Benefit-cost ratio	1.8:1	1.1:1	1.9:1	1.7:1

[a]Estimated at $500 per acre-foot.
[b]100 years at 5 1/8 percent interest.

TABLE 13.--Annual sediment yield reduction and increased grazing capacity resulting from watershed stabilization on critical areas, Sub-basin E, Early Action Program, Sevier River Basin

Item	Unit	National Forest	Public Domain	Private lands	Total
Existing on-site erosion	acre-feet	701	199	24	924
Existing sediment yield[a]	acre-feet	140	40	5	185
Reduction in sediment yield through treatment	acre-feet	31	4	1	36
On-site erosion reduction through treatment	acre-feet	155	12	3	170
Increased forage productivity reflected by increased grazing capacity	animal unit month	12,360	930	250	13,540

[a]Based on 1:5 ratio to erosion

TABLE 14.--Watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin D, Early Action Program, Sevier River Basin

	Contour trench or furrow and seed	Vegetation improvement	Channel stabilization	Drop structures	Road and trail stabilization	Protection fence	Detention dams
	Acres	Acres	Miles	Each	Miles	Miles	Each
National Forest	9,600	21,200	78	61	183	40	0
Public Domain	0	10,000	15	0	20	15	15
Private lands	0	0	0	0	0	0	0

TABLE 15.--Benefits and costs for watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin D, Early Action Program, Sevier River Basin

Annual benefits	National Forest	Public Domain	Private lands	Total
	Dollars	Dollars	Dollars	Dollars
Erosion and sediment control[a]	40,000	12,500	-	52,500
Grazing benefits	19,800	5,600	-	25,400
Redevelopment benefits	14,600	5,600	-	20,200
Secondary benefits	8,700	2,600	-	11,300
Total annual benefits	83,100	26,300	-	109,400
Annual costs				
Total installation costs	880,700	278,500	-	1,159,200
Amortization of installation costs[b]	45,400	14,400	-	59,800
Replacement, operation and maintenance	6,000	2,800	-	8,800
Total annual costs	51,400	17,200	-	68,600
Benefit-cost ratio	1.6:1	1.5:1	-	1.6:1

[a]Estimated at $500 per acre-foot.

[b]100 years at 5 1/8 percent interest.

TABLE 16.--Annual sediment yield reduction and increased grazing capacity resulting from watershed stabilization on critical areas, Sub-basin D, Early Action Program, Sevier River Basin

Item	Unit	National Forest	Public Domain	Private lands	Total
Existing on-site erosion	acre-feet	633	325	-	958
Existing sediment yield[a]	acre-feet	127	65	-	192
Reduction in sediment yield through treatment	acre-feet	16	6	-	22
On-site erosion reduction through treatment	acre-feet	80	25	-	105
Increased forage productivity reflected by increased grazing capacity	animal unit month	4,240	1,850	-	6,090

[a]Based on 1:5 ratio to erosion

SUB-BASIN A (Sanpete Valley)

In Sub-basin A, critical watershed areas include 52,900 acres on National Forests and 14,000 acres on private land. Critical areas by watershed are as follows:

Watershed A1 -	26,800 acres
Watershed A2 -	6,700 acres
Watershed A3 -	16,700 acres
Watershed A4 -	16,700 acres
Sub-basin A -	66,900 acres

Transmountain Diversions

There are 15 transmountain diversions in Sub-basin A. Some of these diversions add additional supplies of water to existing streams thereby aggravating stream bank erosion problems. Other diversions are into ditches which transport the water from the hydrologic divide to the valley floor. One example is the Larsen Ditch north of Ephraim. This crosses the divide through a tunnel at about 10,200 feet elevation, travels 6½ miles westward into Pigeon Creek at about 6,000 feet elevation; an average gradient of over 12 percent. Such ditches have eroded to bedrock and are now steadily becoming wider. They frequently break, releasing water directly down steep sideslopes. The amount of water transported (11,110 acre-feet annually at the source) does not justify the watershed and other resource damage. The Early Action Program could include development of alternative sources of water to eliminate the need for part or all of these diversions.

Critical Area Treatment

Under the Early Action evaluation alternative, 35 percent of the critical area on National Forest lands and 25 percent on private lands were evaluated for treatment. Opportunities evaluated are shown on Table 17. Benefits and costs for critical area treatment is shown in Table 18.

Interrelationships

Treatment in Sub-basin A should have on-site and downstream effects as indicated by Table 19. Sediment reduction could influence water quality and design capacities of structures, both within this sub-basin and downstream. The net effect at the level of treatment evaluated is an annual reduction of 12 acre-feet of sediment.

SUB-BASIN C (Lower Sevier)

In Sub-basin C, critical watershed areas include 161,690 acres on National Forests, 100,000 acres on Public Domain, and 10,300 acres on private land. Critical areas by watershed are as follows:

TABLE 17.--Watershed stabilization opportunities on National Forest, Public Domain, and private lands, Sub-basin A, Early Action Program, Sevier River Basin

	Contour trench or furrow and seed	Vegetation improvement	Channel stabilization	Drop structures	Road and trail stabilization	Protection fence	Detention dams
	Acres	Acres	Miles	Each	Miles	Miles	Each
National Forest	9,400	9,400	73	200	179	39	0
Public Domain	0	0	0	0	0	0	0
Private lands	0	3,500	0	0	0	0	0

TABLE 18.--Benefits and costs for watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin A, Early Action Program, Sevier River Basin

Annual benefits	National Forest	Public Domain	Private lands	Total
	Dollars	Dollars	Dollars	Dollars
Erosion and sediment control[a]	24,000	-	4,500	28,500
Grazing benefits	9,700	-	4,600	14,300
Redevelopment benefits	15,300	-	590	15,890
Secondary benefits	4,900	-	1,300	6,200
Total annual benefits	53,900	-	10,990	64,890
Annual costs				
Total installation costs	920,600	-	33,000	953,600
Amortization of installation costs[b]	47,500	-	1,700	49,200
Replacement, operation and maintenance	6,200	-	330	6,530
Total annual costs	53,700	-	2,030	55,730
Benefit-cost ratio	1.0:1	-	5.4:1	1.2:1

[a] Estimated at $500 per acre-foot.

[b] 100 years at 5 1/8 percent interest.

Watershed C1 - 35,360 acres	Watershed C4 - 13,600 acres
Watershed C2 - 38,080 acres	Watershed C5 - 100,630 acres
Watershed C3 - 35,360 acres	Watershed C6 - 48,960 acres
	Sub-basin C - 271,990 acres

Critical Area Treatment

Under the Early Action evaluation alternative, 30 percent of the critical area on National Forest lands, 21 percent on Public Domain lands, and 25 percent on private lands were evaluated for treatment. Opportunities evaluated are shown on Table 20. Benefits and costs for critical area treatment is shown in Table 21.

Interrelationships

Treatment in Sub-basin C should have on-site and downstream effects as indicated by Table 22. Sediment reduction could influence water quality and design capacities of structures, both within this sub-basin and downstream. The net effect at the level of treatment evaluated is an annual reduction of 47 acre-feet of sediment.

SUB-BASIN B (Sevier Desert)

In Sub-basin B, critical watershed areas include 93,590 acres on National Forest, 25,000 acres on Public Domain, and 5,840 acres on private land. Critical areas by watershed are as follows:

Watershed B1 - 13,690 acres	Watershed B4 - 8,710 acres
Watershed B2 - 14,930 acres	Watershed B5 - 38,570 acres
Watershed B3 - 11,200 acres	Watershed B6 - 37,330 acres
	Watershed B7 - - acres
	Sub-basin B - 124,430 acres

Critical Area Treatment

Under the Early Action evaluation alternative, critical areas on 30 percent of National Forest lands, 32 percent on Public Domain lands, and 25 percent on private lands were evaluated for treatment. Opportunities evaluated are shown on Table 23. Benefits and costs for critical area treatment is shown in Table 24.

Interrelationships

Treatment in Sub-basin B should have on-site and downstream effects as indicated by Table 25. Sediment reduction could influence water quality and design capacities of structures, both within this sub-basin and downstream. The net effect at the level of treatment evaluated is an annual reduction of 23 acre-feet of sediment.

TABLE 19.--Annual sediment yield reduction and increased grazing capacity resulting from watershed stabilization on critical areas, Sub-basin A, Early Action Program, Sevier River Basin

Item	Unit	National Forest	Public Domain	Private lands	Total
Existing on-site erosion	acre-feet	212	-	56	268
Existing sediment yield[a]	acre-feet	42	-	11	53
Reduction in sediment yield through treatment	acre-feet	9	-	3	12
On-site erosion reduction through treatment	acre-feet	48	-	9	57
Increased forage productivity reflected by increased grazing capacity	animal unit month	1,880	-	9,160	11,040

[a]Based on 1:5 ratio to erosion

TABLE 20.--Watershed stabilization opportunities on National Forest, Public Domain and private lands Sub-basin C, Early Action Program, Sevier River Basin

	Contour trench or furrow and seed	Vegetation improvement	Channel stabilization	Drop structures	Road and trail stabilization	Protection fence	Detention dams
	Acres	Acres	Miles	Each	Miles	Miles	Each
National Forest	10,500	37,400	55	27	167	19	0
Public Domain	0	21,500	60	0	5	20	23
Private lands	0	2,650	0	0	0	0	4

TABLE 21.--Benefits and costs for watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin C, Early Action Program, Sevier River Basin

Annual benefits	National Forest	Public Domain	Private lands	Total
	Dollars	Dollars	Dollars	Dollars
Erosion and sediment control[a]	76,000	27,000	3,500	106,500
Grazing benefits	34,900	16,800	3,500	55,200
Redevelopment benefits	21,500	10,800	870	33,170
Secondary benefits	16,300	6,400	1,000	23,700
Total annual benefits	148,700	61,000	8,870	218,570
Annual costs				
Total installation costs	1,295,000	543,500	49,000	1,187,500
Amortization of installation costs[b]	66,800	28,000	2,500	97,300
Replacement, operation and maintenance	8,800	5,400	490	14,690
Total annual costs	75,600	33,400	2,990	111,990
Benefit-cost ratio	2.0:1	1.8:1	3.0:1	2.0:1

[a] Estimated at $500 per acre-foot.
[b] 100 years at 5 1/8 percent interest.

TABLE 22.--Annual sediment yield reduction and increased grazing capacity resulting from watershed stabilization on critical areas, Sub-basin C, Early Action Program, Sevier River Basin

Item	Unit	National Forest	Public Domain	Private lands	Total
Existing on-site erosion	acre-feet	561	347	36	944
Existing sediment yield[a]	acre-feet	112	69	7	188
Reduction in sediment yield through treatment	acre-feet	30	15	2	47
On-site erosion reduction through treatment	acre-feet	152	54	7	213
Increased forage productivity reflected by increased grazing capacity	animal unit month	7,480	5,600	690	13,770

[a] Based on 1:5 ratio to erosion

TABLE 23.--Watershed stabilization opportunities on National Forest, Public Domain, and private lands, Sub-basin B, Early Action Program, Sevier River Basin

	Contour trench or furrow and seed	Vegetation improvement	Channel stabilization	Drop structures	Road and trail stabilization	Protection fence	Detention dams
	Acres	Acres	Miles	Each	Miles	Miles	Each
National Forest	1,100	26,600	56	19	70	58	0
Public Domain	0	7,900	60	0	0	28	1
Private lands	0	1,460	0	0	0	0	2

TABLE 24.--Benefits and costs for watershed stabilization opportunities on National Forest, Public Domain and private lands, Sub-basin B, Early Action Program, Sevier River Basin

Annual benefits	National Forest	Public Domain	Private lands	Total
	Dollars	Dollars	Dollars	Dollars
Erosion and sediment control[a]	37,500	10,000	2,000	49,500
Grazing benefits	26,900	6,200	1,900	35,000
Redevelopment benefits	10,800	2,300	500	13,600
Secondary benefits	9,500	2,400	500	12,400
Total annual benefits	84,700	20,900	4,900	110,500
Annual costs				
Total installation costs	651,100	117,500	28,700	797,300
Amortization of installation costs[b]	33,600	6,100	1,500	41,200
Replacement, operation and maintenance	4,400	1,200	290	5,890
Total annual costs	38,000	7,300	1,790	47,090
Benefit-cost ratio	2.2:1	2.9:1	2.7:1	2.3:1

[a] Estimated at $500 per acre-foot.

[b] 100 years at 5 1/8 percent interest.

TABLE 25.--Annual sediment yield reduction and increased grazing capacity resulting from watershed stabilization on critical areas, Sub-basin B, Early Action Program, Sevier River Basin

Item	Unit	National Forest	Public Domain	Private lands	Total
Existing on-site erosion	acre-feet	409	109	26	544
Existing sediment yield[a]	acre-feet	82	22	5	109
Reduction in sediment yield through treatment	acre-feet	15	7	1	23
On-site erosion reduction through treatment	acre-feet	75	20	4	99
Increased forage productivity reflected by increased grazing capacity	animal unit month	5,320	2,070	380	7,770

[a]Based on 1:5 ratio to erosion

BENEFITS AND JUSTIFICATIONS

Costs of the critical area treatment program are: National Forest programs, $8,018,400; Public Domain programs, $1,473,200; private programs, $220,200. Average annual costs are $468,000 on National Forests, $90,700 on Public Domain and $13,600 on private land. Not included are the planning costs which are estimated on National Forest lands to be $174,000; on Public Domain lands, $32,000; and on private lands, $5,000. Hydrologic surveys and additional planning will be required to coordinate development with other resource uses.

Direct benefits evaluated include an estimated reduction in erosion of 711 acre-feet annually or about 20 percent of the current rate from critical areas on National Forest lands. Downstream reductions in sediment loads is estimated to be 141 acre-feet annually. Increased on-site productivity will provide 45,140 animal unit months annually of increased grazing. Benefits are $793,500 annually which result in a benefit-cost ratio of 1.4:1.

On Public Domain lands, erosion will be reduced 148 acre-feet annually or by about 13 percent of the current rate from critical areas. Downstream sediment loads could be reduced about 46 acre-feet annually. Increased on-site productivity could permit an additional 13,810 animal unit months of grazing use annually. Annual benefits are $161,700 with a benefit-cost ratio of 1.7:1.

Similar data on private lands includes a reduction in erosion of 32 acre-feet annually or about 15 percent of the existing erosion from critical areas. Downstream reduction in sediment yield is estimated to be 11 acre-feet annually. Increased on-site productivity would permit 13,590 additional animal unit months of grazing annually. Evaluated benefits are $40,400 annually and result in a benefit-cost ratio of 2.8:1.

Direct benefits on all lands include a reduction in peak flood flows, and better quality water, improved aesthetics and improved fish habitat. Redevelopment benefits include additional employment opportunities.

ALTERNATIVES

An infinite range of alternatives is possible by varying the intensity and types of treatment. Benefit-cost ratios ranged from 1.4:1 on National Forests to 2.8:1 on private land. This is due to the more comprehensive program planned on National Forests and not to be a greater magnitude of benefits from similar treatment. In some locations sediment reduction can alternately be provided by structural development and in some cases more intensive land treatment may eliminate the need for individual structures. Basin-wide alternatives are described in Chapter IV.

WATER RESOURCE DEVELOPMENT, IMPROVEMENT AND MANAGEMENT

This section describes development to meet the needs for additional supplies and higher quality water for the Basin by 1985. Because of the hydrologic interrelationships within the Basin, these developments must be coordinated and the river system operated as a unit.

Full development of water resources will require more adequate facilities than now exist. Development of surface water storage structures, increased water-use efficiency, and management of the large underground reservoirs could accomplish this goal.

Groundwater management and salvage would have a significant impact on most of the wetland and phreatophyte areas. Areas now using both groundwater and surface irrigation water would require a full supplemental supply. However, most wet meadow areas would be improved through increased forage production.

Water salvage from phreatophytes could be accomplished by lowering and maintaining the water table approximately one foot through pumping and increased irrigation efficiencies. Increased pumping during dry years and recharging during wet years presents additional groundwater development and storage opportunities. Careful evaluation of the aquifer characteristics should be made so that each additional well can be located and designed to best serve the desired purpose.

STRUCTURAL DEVELOPMENT AND GROUNDWATER MANAGEMENT

Structural measures described include multiple-purpose reservoirs, canal lining, water quality improvement structures, and channel improvement. Opportunities to salvage water and regulate the groundwater reservoirs are also described.

Sub-basin F (South Fork Sevier River)

Early Action developments in Sub-basin F include 3 multiple-purpose reservoirs with a total capacity of 22,500 acre-feet; 2 debris basins; 53 miles of canal lining; salvage of 4,810 acre-feet of water; and related on-farm improvements.

A groundwater management potential of 78,000 acre-feet could be utilized. The present use from groundwater averages 500 acre-feet annually. Tables 26, 27 and 28 summarize these development measures in Sub-basin F.

TABLE 26.--Water resource structural developments, Sub-basin F, Early Action Program, Sevier River Basin, Utah

Development	Unit	Development opportunities			Program application			
		Existing	Potential	Needed	Going	Accel-erated	Early Action	Total
Sediment storage	Ac. ft.	-	20,000	15,000	-	-	12,310	12,310
Floodwater								
Storage	Ac. ft.	-	20,000	8,000	-	-	6,025	6,025
Channel	Mile	-	10	3	-	-	2	2
Irrigation water								
Storage	Ac. ft.	32,800	22,000	5,000	-	-	3,600	3,600
Regulation	Ac. ft.	-	10,000	8,000	-	-	6,425[a]	6,425
Canal lining	Mile	10	125	110	15	15	53	83
Recreation								
Water storage	Ac. ft.	20,000	5,000	b	-	-	1,950	1,950
Water surfaces	Acre	1,960	1,000	500	-	-	157	157
Streamflow	Mile	-	36	36	-	-	36	36
Total recreation use	Visitor-day	b	150,000	95,000	-	-	31,810	31,810

[a]Includes 6,350 acre-feet of sediment and floodwater storage capacity.

[b]Not evaluated.

Note: Refer to Tables 50 to 53 for physical and economic data.

TABLE 27.--Salvage and management of groundwater, Sub-basin F, Early Action Program, Sevier River Basin, Utah

Watershed	Salvage		Groundwater management	Area affected
	Gross	Net[a]		
	Acre-feet	Acre-feet	Acre-feet	Acres
F-3	250	0	57,000	200
F-2	1,970	350	b	1,770
F-1	2,590	490	21,000	1,850
Total	4,810	840	78,000	3,820

[a]Amount available for downstream use.

[b]Included in value shown for F-3.

TABLE 28.--Benefits and costs of groundwater development, Sub-basin F, Early Action Program, Sevier River Basin, Utah

Watershed	Wells	Costs		Annual benefits	Benefit-cost ratio
		Total	Annual		
	No.	Dollars	Dollars	Dollars	
F-2	9	139,510	25,600	28,590	1.1:1
F-3	3	46,490	6,250	7,270	1.2:1
F-1	11	198,500	35,940	56,490	1.6:1
Total	23	384,500	67,790	92,350	1.4:1

Watershed F-5 (Hatch) A multiple-purpose reservoir with a total storage capacity of 18,000 acre-feet was evaluated. This includes 9,400 acre-feet for sediment storage, 5,000 acre-feet for floodwater detention, and 3,600 acre-feet for irrigation water storage.

Peak snowmelt runoff and summer cloudburst floods damages the river channel, irrigation structures and cropland areas. Annual floodwater detention and sediment storage benefits from this reservoir are estimated to be $29,660. Storage and regulation of the river flow could provide a stable water supply and reduce the size and cost of new downstream diversion structures. Benefits are estimated to be $21,090 annually.

By staging the principal spillway outlet, an average water supply of 5,000 acre-feet of flood prevention storage capacity was estimated available for downstream irrigation. Benefits from this use are $37,500 annually.

Recreational benefits include water skiing, boating, fishing, picnicking and river fishing below the dam. Facilities to provide for this use should include boat ramps, parking areas, sanitation developments, a water system, shade and picnic developments. Reservoir-based recreation would provide about 19,440 visitor-days of use annually with a benefit of $21,280.

Improved water quality and regulation of river flows could enhance fishing for 21 miles downstream where, at present, flow is intermittent. This change would result in an estimated 5,250 visitor-days use per year with an annual recreation benefit of $5,500.

Watershed F-2 (Panguitch Valley) A debris basin is proposed in Red Canyon with a capacity of 560 acre-feet for sediment and 140 acre-feet for floodwater storage. Benefits were estimated to be $11,460 annually.

A debris basin in Casto Canyon was evaluated with a capacity of 600 acre-feet of sediment and 160 acre-feet of floodwater storage with annual benefits of $12,020.

Consolidation of East Panguitch, Long, East Bench and McEwen canals into one 16-mile system following the general alignment of the old State Canal could reduce operation and maintenance costs, eliminate diversion structures and reduce seepage losses by about 5,300 acre-feet annually. Total benefits are estimated to be $59,150 annually.

Evaluations were based on installation of 9 shallow wells in the wetland area. The benefits include better water regulation and water salvage of 1,970 acre-feet annually from phreathopytes. Cropland conversion benefits from wells are $8,380. Total benefits from the wells are estimated to be $20,880 annually.

Watershed F-3 (Panguitch Creek) Floods from Panguitch Creek occur almost annually causing damage to the West Panguitch Irrigation Company system. Also, freezing and thawing conditions block Panguitch Creek and cause winter flooding in the city of Panguitch. Ice accumulation also causes breaks in the West Panguitch Canal. A multiple-purpose storage facility on Panguitch Creek near the irrigated area, channel improvement, canal lining and consolidation of some of the distribution laterals could alleviate these problems and increase the overall irrigation efficiency.

A multiple-purpose structure could provide 50 acre-feet of sediment storage, 225 acre-feet of floodwater storage (50-year storm),

75 acre-feet of regulatory irrigation water storage and 150 acre-feet of recreation storage. Flood prevention benefits from the reservoir and channel work are estimated at $6,510 annually, water regulation benefits at $2,220 annually, and water-based recreation benefits at $4,700 annually.

There are 18 miles of canal lining evaluated in the main distribution system along with consolidation of major distribution laterals. This should result in reduced operation and maintenance costs along with increased irrigation efficiencies with benefits estimated at $17,080 annually.

Three wells operated in conjunction with those in Watershed F-2 could be used to manage the Panguitch Valley groundwater reservoir, salvage 250 acre-feet of water from phreatophyte areas, and augment downstream river flows. Well benefits are $5,000 annually.

Watershed F-1 (Circleville) Canal seepage losses average about 11,800 acre-feet annually. Water supplies are inadequate as all diversions are from direct flow rights and users experience late summer shortages.

Development measures could include a multiple-purpose reservoir located near the head of Circleville Canyon and canal lining. Total capacity is estimated at 4,000 acre-feet which includes 1,700 acre-feet of sediment, 500 acre-feet of floodwater, and 1,800 acre-feet with 140 surface acres of recreation storage. The sediment and floodwater pools could also provide regulatory storage for the 50-year life of the structure. This structure will facilitate irrigation water management, reduce operation and maintenance costs, prevent inundation of the downstream flood plain, reduce winter ice accumulation on cropland and in irrigation systems. Flood and sediment damage reduction benefits are estimated at $8,120 annually. Agricultural water management benefits are estimated to be $10,430 annually.

The recreation pool would provide boating, water skiing and fishing and improve the aesthetics of a camping and picnicking area, however, benefits from the latter two were not included. River flow regulation could provide a downstream fishery in a 15-mile reach of the river now nonexistent because of no-flow periods. Total recreation use is estimated at 9,240 visitor-days with annual benefits of $13,860.

Canal lining of 19 miles includes a 4-mile extension of the West Circleville Canal into the Junction area. Capacities range from 60 cfs to 20 cfs.

The lining of canals now servicing 4,580 acres of irrigated land could reduce seepage losses by 1,350 acre-feet of root-zone water. Benefits are estimated at $47,250 annually. The West Circle Valley canal lining extension could serve 1,400 acres of irrigated land now served by the Junction Canal and Junction Middle Ditch in Watershed D-8. About 200 acres of irrigated nonrotated cropland in Watershed D-8 and 300 acres in Watershed F-1, and 100 acres of wetlands in Watershed

F-1 could also benefit from this development. Annual benefits are estimated to be $14,120.

Eleven wells are evaluated within the wetland area to aid in controlling the water table and salvage 2,590 acre-feet of water, manage the Circle Valley groundwater reservoir and supply irrigation water to converted lands in the immediate area. Groundwater reservoir management will be necessary to partially offset downstream impacts of other measures. Annual benefits from the wells are about $42,000.

Hydrologic Interrelationships Watershed stabilization measures on critical areas in Sub-basin F could reduce the sediment yield to the river by 58 acre-feet annually. Structural developments could trap 145 acre-feet of sediment.

A reservoir located in Watershed F-5 could alter the monthly and annual flow pattern of the river. The long term average river flow volume should remain the same except for an increase in annual water surface evaporation of 1,500 acre-feet. Water quality will be increased through reduced sediment loads of about 90 acre-feet annually.

Red Canyon and Casto Canyon debris basins will have a negligible effect on river flow patterns. They will improve the water quality by trapping a combined sediment load of about 20 acre-feet annually. West Panguitch Creek Reservoir will trap one acre-foot of sediment annually.

The balance of the measures in Watersheds F-2 and F-3 are estimated to reduce the annual volume of flow in the river as shown below:

	Net effect on downstream flow
Increased water surface evaporation, F-3	90 acre-feet
Increased irrigated lands consumptive use	2,030 acre-feet
Decreased wetlands consumptive use	2,510 acre-feet
Net increase in annual river flow	390 acre-feet

The multiple-purpose reservoir in Circleville Canyon reduces the river flow by an increase in water surface evaporation of 550 acre-feet annually. However, about 34 acre-feet of sediment will be removed from the river flow annually. Regulation of river flows changes the monthly but not the annual volume.

The change in river outflow from Watershed F-1 resulting from increased water surface evaporation and land use conversion is estimated as follows:

	Net effect on downstream flow
Increased water surface evaporation	550 acre-feet
Increased irrigated land consumptive use	1,410 acre-feet
Decreased wetland consumptive use	1,690 acre-feet
Net decrease in annual river flow	270 acre-feet

Table 29 shows the average annual water-budget values for the 1931-1960 base period and changes resulting from the Early Action Program. Surface water diversions are reduced about 45,750 acre-feet annually through more efficient irrigation water management.

TABLE 29.--Hydrologic effects of Early Action Program, Sub-basin F, Sevier River Basin

Item	Present	Early Action[a]	Difference
	Ac. ft.	Ac. ft.	Ac. ft.
Surface water diversion	106,360	60,610	-45,750
Well diversions	500	7,745	+ 7,245
Total diversions[b]	106,860	68,355	-38,505
Tributary inflow	123,230	123,230	0
Precipitation on cropland	16,200	17,470	+ 1,270
Precipitation on wetlands	4,670	3,400	- 1,270
Total water available	144,100	144,100	0
Actual consumptive use on croplands	42,190	45,630	+ 3,440
Actual consumptive use on wetlands	12,200	8,000	- 4,200
Reservoir water surface evaporation, net	0	2,140	+ 2,140
M&I use and cropland water surface evaporation	1,280	1,280	0
Total water use[b]	55,670	57,050	+ 1,380
Total outflow[c]	88,430	87,050	- 1,380

[a]Early Action program conditions include increased irrigation efficiencies from all development measures including on-farm land treatment practices.

[b]Total diversions and total water used do not reflect an irrigation efficiency. The effects of direct use from groundwater are not shown on this summary.

[c]Total outflow=Total water available-Total water used.

The changed precipitation supplies to irrigated cropland and wetland areas results from acreage changes in these categories. Water salvage and less area account for reduced wetland consumptive use.

The net result of all development measures in Sub-basin F is improved water quality through a reduction in sediment of 203 acre-feet and an annual river outflow of 1,380 acre-feet less than the base period average. Development measures downstream could compensate for this reduced flow so that irrigation water requirements are satisfied.

Alternative Development Opportunities Improved water quality and flood prevention could be accomplished by construction of a larger number of small structures on tributary drainages such as Wilson Canyon, Rock Pass Canyon, Graveyard Wash, Three Mile Creek, and Sanford Wash or through a more intensive watershed stabilization program. Another combination could be a reduced capacity of Hatch and Circleville Canyon Reservoirs with some of the above debris basins on tributary drainages.

A stable irrigation water supply could be realized through alternative surface or groundwater storage by increasing one and decreasing the other. Alternate but varying less feasible storage sites include three more in Circleville Canyon, one above Panguitch on the Sevier River and one on Mammoth Creek. Increased efficient use of irrigation water is possible by increasing the off-farm development or on-farm land treatment measures.

Water-based recreation is more limited in alternate possibilities. Consideration should be given to reservoirs for recreation use only. Total cost would be less but the economic returns may also be smaller in proportion. A conservation pool should be considered for the reservoir near Hatch.

Sub-basin E (East Fork Sevier River)

The Early Action Program includes 3 multiple-purpose reservoirs with a capacity of 1,950 acre-feet and 15 miles of lining and pipelines. Two reservoirs are enlargements of existing facilities.

Structural developments described do not eliminate the existing irrigation water shortage in the Tropic area. This area receives irrigation water by transmountain diversion from the Sevier River Basin so further development from this source is limited by the ability of the water users to purchase additional rights.

Exclusive of Johns Valley, the groundwater reservoirs in Sub-basin E have a management potential of 15,000 acre-feet. Total water salvage of 7,280 acre-feet could be utilized for supplemental use within the area and to offset downstream impacts. At present, there is no groundwater pumped from wells for irrigation. Tables 30, 31 and 32 show the physical and economic data.

TABLE 30.--Water resource structural development, Sub-basin E, Early Action Program, Sevier River Basin, Utah

Development	Unit	Development opportunities			Program application			
		Existing	Potential	Needed	Going	Accel-erated	Early Action	Total
Sediment storage	Ac. ft.	a	1,000	800	-	-	650	650
Floodwater storage	Ac. ft.	a	600	350	-	-	270	270
Irrigation water								
Storage	Ac. ft.	9,460b	2,500	1,500	-	-	800	800
Regulation	Ac. ft.	-	900	200	-	-	-	-
Canal lining	Miles	12	100	50	-	10	15	25
Recreation								
Water storage	Ac. ft.	-	330	300	-	-	230	230
Water surfaces	Acres	-	50	50	-	-	16	16

[a] Not evaluated. Existing reservoirs do not have storage allocated for these purposes.

[b] Does not include Otter Creek Reservoir as it supplies water to Sub-basin D.

Note: Refer to Tables 50 to 53 for economic evaluations.

TABLE 31.--Salvage and management of groundwater, Sub-basin E, Early Action Program, Sevier River Basin

Watershed	Salvage		Groundwater management	Area affected
	Gross	Net		
	Ac. ft.	Ac. ft.	Ac. ft.	Acre
E-3	1,980	410	-	2,150
E-1	5,300	2,060	-	5,440
Total	7,280	2,470[a]	15,000[b]	7,590

[a] Amount available for downstream use.

[b] Includes both Watersheds E-3 and E-1.

Note: All values for Watershed E-3 include minor values for Watershed E-4.

TABLE 32.--Economic evaluation of groundwater development, Sub-basin E, Early Action Program, Sevier River Basin

Watershed	Wells	Costs		Annual benefits	Benefit-cost-ratio
		Total	Annual		
	No.	Dollars	Dollars	Dollars	
E-3	5	77,500	10,460	43,420	4.2:1
E-1	11	170,500	23,040	90,380	3.9:1
Total	16	248,000	33,500	133,800	4.0:1

Watershed E-5 (Tropic) Scattered irrigated lands and a fluctuating water supply makes efficient use of irrigation water difficult. The average annual water-budget indicates a deficit of 2,790 acre-feet.

Enlargement of Tropic Reservoir could increase the total storage capacity by 400 acre-feet providing a 100-year sediment storage capacity of 200 acre-feet and 200 acre-feet of irrigation water storage. This could increase the average diversion of irrigation water to the Tropic area by 300 acre-feet if the sediment storage capacity were used as it fills.

Benefits for sediment storage in Tropic Reservoir were not evaluated, but increased irrigation water storage could provide about 90 acre-feet of root-zone moisture at an annual benefit of $3,220. Lining an additional 4 miles of the conveyance system could increase the root-zone supply by about 330 acre-feet with an annual benefit of $12,150. A pipeline through a short section of Water Canyon could save an additional 160 acre-feet of root-zone water with annual benefits of $5,710.

Watershed E-3 (Antimony) A reservoir on Antimony Creek could provide storage for flood prevention and recreation. Floodwater and sediment storage of 720 acre-feet should reduce sediment deposits on croplands and in canals and improve fish habitat with annual benefits of $7,030. Also, a permanent recreation pool of 230 acre-feet could be used as a fishery. Recreation from increased fishing along with camping and sight-seeing provides annual benefits of $9,480.

Irrigated land served by the Antimony Bench Irrigation Company could be served by a gravity sprinkler system, eliminating the present local irrigation water shortage. Increased irrigation efficiencies will provide an annual benefit of $36,180. Five wells installed for irrigation water management and salvage could yield about 1,560 acre-feet annually with benefits of $35,540.

Watershed E-1 (Koosharem) Koosharem Reservoir has a present storage capacity of 3,860 acre-feet. The dam could be raised 6 feet and provide an additional 600 acre-feet of irrigation water storage. The increased storage would provide additional irrigation water regulation and 150 acre-feet of root-zone mositure with an annual benefit of $3,750.

Heavy recreation use of the existing reservoir has indicated a need for increasing the capacity of this facility and for this reason a conservation pool should be considered in future planning along with associated recreation facilities. No additional storage was provided for recreation, but annual recreation benefits of $4,850 could accrue from the increased capacity and surface area.

Eleven shallow wells are proposed to regulate groundwater supplies and reduce the direct use of groundwater by phreatophytes. Annual benefits are $73,710 annually.

Hydrologic Interrelationships Sediment reduction to improve water quality includes retention of 5 acre-feet annually in the Antimony Creek Reservoir and 36 acre-feet annually through watershed stabilization. The average annual increase in trans-watershed diversion of irrigation water to the Tropic area from East Fork of the Sevier River will be 300 acre-feet by utilizing the sediment storage capacity as it fills. The Tropic Reservoir enlargement restores the irrigation water storage capacity now reduced by sedimentation.

Increased irrigation water use in Watershed E-3 of 1,680 acre-feet and increased water surface evaporation of 60 acre-feet will reduce annual downstream flows by 1,740 acre-feet. The net effect of development measures on downstream flows is shown below:

	Effect on downstream flow
Increased net water surface evaporation	60 acre-feet
Increased irrigated lands consumptive use	2,520 acre-feet
Decreased wetlands consumptive use	1,480 acre-feet
Decrease in downstream supply	1,100 acre-feet

Enlargement of Koosharem Reservoir in Watershed E-1 increased the irrigation water storage capacity and recreation potential. Lowering of the groundwater level could allow conversion of 2,400 acres of non-rotated irrigated croplands and 500 acres of wetlands to irrigated rotated cropland. The net effects of improvement measures on the outflow are shown below:

	Effect on downstream flow
Water surface evaporation, net	280 acre-feet
Decreased inflow from E-5	330 acre-feet
Increased irrigated lands consumptive use	1,540 acre-feet
Decreased wetlands consumptive use	3,600 acre-feet
Increase in downstream supply	1,450 acre-feet

In Sub-basin E, consumptive use on wetlands will be decreased by 5,080 acre-feet which will offset increased consumptive use on croplands and water surface evaporation and provide an increased outflow of 350 acre-feet to Sub-basin D (Table 33).

Alternative Development Opportunities Alternate developments that should be considered include multiple-purpose reservoirs on North Canyon Creek, Burr Creek and Greenwich Creek. A structure in Black Canyon for regulatory irrigation water storage and flood prevention could reduce periodic cleaning now required along the Otter Creek diversion canal.

Enlargement of Tropic Reservoir should consider establishment of an adequate conservation pool for fish and wildlife, launching facilities for boats, and redesign of the outlet works to prevent flushing fish downstream which is presently a problem.

Koosharem Reservoir should be considered for use as a recreation facility only. Water for irrigation could be pumped from the groundwater reservoir.

Increased on-farm development could offset a portion of the groundwater development. An additional possibility is development of the Johns Valley groundwater basin along with additional irrigation water diversions into the Tropic area.

A pipeline in the Henderson Creek area near Tropic would conserve water now lost through seepage. Regulatory storage along the Tropic and East Fork canals should also be considered. These latter two developments would have negligible downstream impacts.

TABLE 33.--Hydrologic effects of Early Action Program, Sub-basin E, Sevier River Basin

Item	Present	Early Action[a]	Difference
	Ac. ft.	Ac. ft.	Ac. ft.
Surface water diversion	59,150	44,310	-14,840
Well diversion	0	5,000	+ 5,000
Total diversions[b]	59,150	49,310	- 9,840
Surface water inflow from E-5	8,410	8,080	- 330
Tributary inflow	77,910	77,910	0
Precipitation on croplands	13,470	14,190	+ 720
Precipitation on wetlands and water surfaces	4,620	3,900	- 720
Total water available	104,410	104,080	- 330
Actual consumptive use on croplands	28,140	32,200	+ 4,060
Actual consumptive use on wetlands	15,690	10,610	- 5,080
Reservoir water surface evaporation, net	8,490	8,830	+ 340
M&I use and cropland water surface evaporation	560	560	0
Groundwater outflow to E-5	200	200	0
Total water use[b]	53,080	52,400	+ 680
Total outflow[c]	51,330	31,680	+ 350

[a]Early Action program conditions include increased irrigation efficiencies from all development measures including on-farm land treatment practices.

[b]Total diversions and total water used do not reflect an irrigation efficiency. The effects of direct use from groundwater are not shown on this summary.

[c]Total outflow=Total water available-Total water use.

Water-based recreation developments are extremely limited. Permanent conservation pools in all other reservoirs, proposed and existing, should be considered.

Sub-basin D (Central Sevier River)

Early Action Program water resource developments in Sub-basin D include 2 debris basins, 80 miles of canal lining and 15 miles of pipelines.

Groundwater reservoirs have a management potential of 80,000 acre-feet. Estimates indicate 16,490 acre-feet of water could be salvaged to offset downstream impacts and provide supplemental irrigation water within the area. Present irrigation water use from groundwater averages 2,200 acre-feet annually (Tables 34,35 and 36).

TABLE 34.--Water resource structural development, Sub-basin D, Early Action Program, Sevier River Basin, Utah

Development	Unit	Development opportunities			Program application			
		Existing	Potential	Needed	Going	Accelerated[a]	Early Action	Total
Sediment storage	Acre-feet	90[b]	13,190	3,200	-	120	2,300	2,420
Floodwater								
Storage	Acre-feet	120[b]	6,000	2,300	-	70	1,200	1,270
Channel	Mile	10	20	5	-	-	-	-
Irrigation water								
Storage	Acre-feet	128,780	1,500	500	-	-	-	-
Regulation	Acre-feet	2,120	1,500	2,000	-	-	-	-
Canal lining	Mile	20	190	140	5	30	95	130
Recreation								
Water storage	Acre-feet	[c]	3,000	2,000	-	-	-	-
Water surface	Acre	3,330	400	[c]	-	-	-	-
Streamflow	Mile	80	20	[c]	-	-	-	-
Total recreation use	Visitor-day	[c]	[c]	[c]	-	-	-	-

[a]To be installed under the Monroe-Annabella Watershed Project.

[b]Not completely evaluated. Values shown are in Watershed D-3. Existing major reservoirs have no capacity allocated directly for flood prevention or recreation.

[c]Not evaluated on a sub-basin basis.

Note: Refer to Tables 50 to 53 for physical and economic data.

TABLE 35.--Salvage and management of groundwater, Sub-basin D, Early Action Program, Sevier River Basin

Watershed	Salvage		Groundwater management	Area affected
	Gross	Net		
	Ac. ft.	Ac. ft.	Ac. ft.	Acres
D-8	780	440	12,800	1,380
D-1, 4, 6 and 7	9,270	140	36,000	5,550
D-2 and 3	6,440	3,120	31,200	4,980
Total	16,490	3,700	80,000	11,910

TABLE 36.--Economic evaluation of groundwater development, Sub-basin D, Early Action Program, Sevier River Basin

Watershed	Wells	Cost		Annual benefits	Benefit-cost-ratio
		Total	Annual		
	No.	Dollars	Dollars	Dollars	
D-8	5	77,410	14,320	35,820	2.5:1
D-1,4,6 and 7	14	216,780	29,430	100,050	3.4:1
D-2 and 3	12	185,810	25,230	77,730	3.1:1
Total	31	480,000	68,980	213,600	3.1:1

Watershed D-8 (Kingston-Junction) Water is presently diverted with three structures into the Allen, West, Zabriski and Nielson canals. Sections of these canals run parallel and duplicate operation and maintenance costs. Consolidation of the West, Allen and Nielson canals and construction of a new diversion would provide a single system on the south side of the river and the Zabriski canal on the north. Concrete lining of 2.5 miles of main canal and 2.5 miles of laterals would replace 7 miles of earth canals and laterals on the south side. This improved system would reduce seepage losses and increase crop yields. Benefits are estimated to be $16,000.

City Creek Irrigation Company near Junction has lined part of its delivery system. Extending this lining could reduce the seepage loss by 370 acre-feet. Benefits are estimated to be $8,870.

Five wells were evaluated to drain selected areas and provide groundwater management. Some groundwater could be used to irrigate nearby converted and cultivated lands and the balance made available for downstream use. Benefits are estimated to be $28,920.

Watershed D-1 (Richfield) Flat Canyon, Cottonwood Creek and Willow Creek are major sources of floodwater and sediment which cause serious damage to the Richfield area. Average annual flood damages are: Flat Canyon, $15,500; Cottonwood Creek, $14,300; and Willow Creek, $7,600.

Floods from Flat Canyon and Cottonwood Creek could be controlled with structures. Outlet works could be provided to service some cropland irrigation requirements. Flood retarding structures on Flat Canyon and Cottonwood Creek could reduce Highway Interstate-70 construction costs by $650,000. Peak flood flows would be reduced from 5,000 and 7,000 cfs (100-year storm), respectively, to flows of approximately 150 cfs.

Flood prevention benefits from the Flat Canyon debris basin are estimated to be $15,530. Amortized savings from Interstate-70 construction are estimated at $18,060. Restricted release of floodwater could provide an estimated $1,860 agricultural water management benefit.

Flood prevention benefits from the Cottonwood Creek debris basin are estimated to be $14,330. Benefits accruing from reduced highway construction costs amount to $15,480 annually. Floodwater releases could provide an annual agricultural water management benefit of $710.

Consolidation of the Elsinore, Joseph, Richfield and Vermillion canals with the existing Sevier Valley canal could reduce current irrigation water shortages. The main canal should be lined for approximately 30 miles with a design capacity of 560 cfs at the upper end and stepped reductions to 150 cfs at the lower end. Thirty laterals totaling 42 miles in length with a capacity of 17 cfs would service the irrigated lands below. Increased water available is estimated at 7,500 acre-feet annually. Annual benefits are estimated to be $262,420.

As a means of regulating the total Basin water resource, eleven wells in Watershed D-1, two wells in Watershed D-6 and one well in Watershed D-4 were investigated as one evaluation unit. They could provide irrigation water to nearby converted and existing croplands along with needed drainage and salvage of water for downstream use. Benefits are estimated to be $80,760.

Watersheds D-2 and D-3 (Glenwood-Venice) Several floods from Peterson Creek have occurred during recent years causing extensive damage. Annual irrigation water shortages are about 80 acre-feet. Drainage of rotated croplands with high water tables adjacent to wetlands would increase yields. Installation of a gravity sprinkler system could eliminate the present root-zone irrigation water shortage and supply supplemental water to 2,000 acres of converted lands. Benefits are estimated to be $7,610. Part of the supplemental water could be diverted from Water Canyon through a pipeline to the State fish hatchery near Glenwood and then into the sprinkler irrigation system. The additional water could increase production at the hatchery. Benefits are estimated as follows: Fishery, $1,000; Water Canyon pipeline, $2,030; and sprinkler irrigation system, $4,900.

Twelve wells could be used to drain parts of the wetlands, salvage water, and provide groundwater management to supply

downstream needs. These wells would operate conjunctively with those in Watershed D-1. Benefits are estimated to be $62,240 annually.

Hydrologic Interrelationships Watershed stabilization in Sub-basin D could reduce sediment yield by 22 acre-feet annually. Debris basins could trap 23 acre-feet of sediment annually.

Conversion of 800 acres of irrigated nonrotated cropland in Watersheds D-7 and D-8 to irrigated rotated cropland should have a negligible effect on downstream flows.

Reservoirs in Watershed D-1 would increase water surface evaporation by 150 acre-feet annually. Increased efficiencies through canal lining and irrigation system consolidation could save 7,500 acre-feet of root-zone water annually. The average irrigation water shortage of 4,160 acre-feet in Watershed D-1 and 4,040 acre-feet in Watershed D-4 could be eliminated by improved irrigation systems and use of water salvaged from wetlands.

Net effect on downstream supply of increased water surface evaporation, land use conversion and satisfying irrigation water shortages in Watersheds D-1, D-4 and D-6 is shown below:

	Effect on downstream flow
Increased net surface evaporation	150 acre-feet
Increased irrigated land consumptive use	10,680 acre-feet
Decreased wetlands consumptive use	2,750 acre-feet
Total decrease in outflow	8,080 acre-feet

Elimination of late summer, dry year irrigation water shortages in Watersheds D-2 and D-3 would reduce the average outflow from this area by about 80 acre-feet annually. Conversion of 1,500 acres of wetland and 500 acres of nonrotated irrigated land to rotated cropland increases available water supplies by 550 acre-feet. Net effect of land use conversion and satisfying irrigation water shortages on downstream flows are shown below:

	Effect on downstream flow
Increased cropland consumptive use	3,650 acre-feet
Decreased wetland consumptive use	4,120 acre-feet
Total increase in downstream flow	470 acre-feet

The total effect of the salvage and management program in Sub-basin D reduces consumptive use in the wetlands by 11,740 acre-feet. Of this

total, 6,870 acre-feet is a result of cropland conversion and the remaining 4,870 acre-feet is water salvage from wetland areas.

Table 37 shows the annual water-budget for present and Early Action Program conditions. Inflow into the sub-basin is 1,030 acre-feet less with upstream developments. Total diversions are increased to overcome irrigation water shortages and provide full supplies to converted lands. Total outflow from Sub-basin D is decreased by 3,760 acre-feet.

TABLE 37.--Hydrologic effects of Early Action Program, Sub-basin D, Sevier River Basin

Item	Present	Early Action[a]	Difference
	Ac. ft.	Ac. ft.	Ac. ft.
Cropland consumptive use deficit	8,390	0	- 8,390
Surface water diversion	189,690	198,200	+ 8,510
Well diversion	2,200	12,000	+ 9,800
Total diversions[b]	191,890	210,200	+18,310
Surface water inflow	136,290	136,270	- 20
Groundwater inflow	3,470	2,460	- 1,010
Tributary inflow	106,870	106,870	0
Precipitation on cropland	32,240	34,020	+ 1,780
Precipitation on wetlands and water surfaces	7,740	5,970	- 1,770
Total water available	286,610	285,590	- 1,020
Actual consumptive use on cropland	104,970	119,300	+14,330
Actual consumptive use on wetland	39,150	27,410	-11,740
Reservoir water surface evaporation, net	6,930	7,080	+ 150
M&I use and cropland water surface evaporation	5,560	5,560	0
Total water use[b]	156,610	159,350	+ 2,740
Total outflow[c]	130,000	126,240	- 3,760

[a]Early Action program conditions include increased irrigation efficiencies from all development measures including on-farm land treatment practices.

[b]Total water use and total diversions do not reflect an irrigation efficiency. The effects of groundwater use are not shown in this summary.

[c]Total outflow=Total water available-Total water used.

Alternative Development Opportunities Alternative irrigation water storage and flood prevention reservoirs include sites on Beaver Creek, Clear Creek, Flat Canyon, Willow Creek and Peterson Creek. Regulatory structures should also be considered on Ten Mile Creek, North and South Cedar Ridge Canyons and the tributaries to Clear Creek. Total capacity of these exceeds 10,000 acre-feet.

Canal lining and consolidation of Monroe, Monroe South Bend, and Wells canals presents alternative development opportunities in Watershed D-4. Also, individual canals in the Richfield area could be lined without consolidation.

The groundwater reservoir in the Richfield area is next largest in the Basin. Development of this resource to a greater extent should provide additional benefits, especially if increased on-farm development and land use conversion were included.

Sub-basin A (San Pitch River)

Water resource developments include one multiple-purpose reservoir, one debris basin, 162 miles of canal lining, and 41 miles of pipelines. The underground reservoir in Sanpete Valley has an estimated management potential of 300,000 acre-feet. The present groundwater use is 14,240 acre-feet (Tables 38, 39, and 40).

Watershed A-1 (North Sanpete) Structural measures in the North Sanpete Work Plan, which was completed in September, 1961, include regulating reservoirs, diversions, canal lining and pipelines. This plan called for a reservoir on Gooseberry Creek, a tributary to the Price River. The water was to be stored and diverted by tunnel into Cottonwood Creek but water-right litigation has delayed action. Project benefits shown in the watershed work plan were adjusted to allow for work completed to date. Concrete lining of 55 miles of canals with benefits of $117,550 and installation of 38 miles of pipelines with benefits of $100,130 could reduce the average root-zone water shortage by 3,520 acre-feet. Stream channel improvement on 0.5 mile could aid in flood prevention with annual benefits of $500.

Two fisheries and one waterfowl development are included. The Spring City fishery could provide 200 visitor-days use on a 3-acre development. Benefits are estimated to be $300 annually. Fairview Lakes fishery could provide 8,930 visitor-days use on 134 water surface acres with annual benefits of $13,400. A waterfowl development west of Mount Pleasant could provide 535 acres of wildlife habitat with 13,330 visitor-days use and benefits of $20,000 annually.

In addition to development in the work plan, installation of thirty wells could salvage 9,140 acre-feet of water. Pumping would enable conversion of 1,600 acres of wetlands to improved cropland and provide supplemental water for irrigation. Benefits are estimated to be $137,080.

TABLE 38.--Water resource structural development, Sub-basin A, Early Action Program, Sevier River Basin, Utah

Development	Unit	Development opportunities			Program application			
		Existing	Potential	Needed	Going	Accel-erated	Early Action	Total
Sediment storage	Ac. ft.	-	2,000	1,500	-	-	660	660
Floodwater								
Storage	Ac. ft.	-	600	500	-	-	420	420
Channel	Mile	-	15	10	-	-	0.5	0.5
Irrigation water								
Storage	Ac. ft.	4,900	26,000	20,000	-	-	1,420	1,420
Regulation	Ac. ft.	-	1,100	1,000	-	-	-	-
Canal lining	Mile	20	430	250	10	10	150	170
Recreation								
Water storage	Ac. ft.	-	6,000	2,000	-	-	-	-
Water surfaces	Acre	600	700	250	-	-	80	80
Streamflow	Mile	30	60	[a]	-	-	-	-
Total recreation use	Visitor-day	-	[a]	[a]	-	-	2,350	2,350

[a]Not evaluated.

Note: Refer to Tables 50 to 53 for physical and economic data.

TABLE 39.--Salvage and management of groundwater, Sub-basin A, Early Action Program, Sevier River Basin

Watershed	Salvage		Groundwater management	Area affected
	Gross	Net		
A-1	9,140	6,860	96,000	9,440
A-2	8,080	6,090	84,000	8,340
A-3	1,020	310	30,000	710
A-4	8,620	6,480	90,000	9,890
Total	26,860	19,740	300,000	28,380

TABLE 40.--Economic evaluation of groundwater development, Sub-basin A, Early Action Program, Sevier River Basin

Watershed	Wells	Total	Annual	Annual benefits	Benefit cost-ratio
	No.	Dollars	Dollars	Dollars	
A-1	30	388,010	64,320	174,270	2.7:1
A-2	26	339,510	56,290	152,480	2.7:1
A-3	9	121,250	20,100	54,450	2.7:1
A-4	28	363,770	61,850	163,240	2.6:1
Total	93	1,212,540	202,560	544,440	2.7:1

Watershed A-2 (Fountain Green) A reservoir in Big Hollow could control sediment and floodwater and provide regulatory storage. Reservoir capacities include 775 acre-feet of flood prevention and 1,425 acre-feet of regulatory storage to partially offset the average irrigation water shortage of 5,100 acre-feet. Winter flows from Big Spring are presently diverted into the existing irrigation system causing damage to concrete lining and reducing yields on 1,000 acres of irrigated land. A collection pipe would prevent this damage by transporting winter water to the Big Hollow Reservoir. Flood prevention benefits are estimated to be $2,500 annually. Prolonged concrete lining life and increased yields provide annual flood damage benefits of $13,180. Irrigation water storage benefits are estimated to be $29,270. Annual incidental recreation benefits derived from use of the sediment pool and temporary storage are estimated to be $1,320.

Lining 21 miles of Fountain Green Irrigation Company and Wales Reservoir-Silver Creek Irrigation Company canals could reduce maintenance costs and increase conveyance efficiencies. The canal lining would increase root-zone water supplies by 844 acre-feet with benefits of $32,760 annually.

A total of three miles of pipelines in Peach Canyon, Reese Spring and Current Creek could reduce seepage by 114 acre-feet and provide $4,320 in benefits.

Twenty-six wells could salvage 8,080 acre-feet of water and convert 1,400 acres of wet meadows to rotated cropland and improved pasture. Salvage would also augment downstream river flows. Benefits are estimated to be $119,940.

Watershed A-3 (Ephraim) The average annual root-zone water supply shortage is 3,070 acre-feet. Canal lining for 60 miles of the Ephraim Irrigation Company and 15 miles for the Willow Creek Irrigation Company could increase irrigation water to the root-zone by 2,520 acre-feet annually with benefits of $87,701.

These wells will lower the groundwater. Nine wells could salvage 1,020 acre-feet of water, lower the water table and allow conversion of 5,000 acres of wet meadows and other phreatophytes to crop or pasture land. Benefits are $42,480 annually.

Watershed A-4 (Manti) A debris basin located in the mouth of Manti canyon could provide 50-year sediment storage of 260 acre-feet. Flood prevention benefits are estimated to be $17,980. This facility could provide water based recreation.

Short-term fluctuations in streamflow contribute to an overall irrigation efficiency of 35 percent. Eleven miles of canal lining for the Manti Reservoir and Irrigation Company would reduce root-zone water shortages by 868 acre-feet. Benefits are estimated to be $31,650.

Twenty-eight wells could salvage 8,620 acre-feet of water and allow conversion of 1,500 acres of wet meadows to improved pasture and rotated cropland. Benefits are estimated to be $128,510.

Hydrologic Interrelationships Sediment reduction includes annual retention of 5 acre-feet in the Manti Canyon debris basin, 4 acre-feet in Big Hollow Reservoir and 12 acre-feet in Sub-basin A through watershed stabilization.

Canal lining and pipelines in Watershed A-1 could eliminate the present irrigation water shortage of 6,920 acre-feet. This, and conversion of 1,600 acres of wetlands to irrigated rotated cropland along with water salvage results in an increased outflow:

	Net effect on downstream flow
Increased cropland consumptive use	10,690 acre-feet
Decreased wetlands consumptive use	12,680 acre-feet
Increased outflow	1,990 acre-feet

Increased water surface evaporation from Big Hollow Reservoir in Watershed A-2 would reduce the annual outflow by 140 acre-feet. Conversion of wetlands to irrigated rotated cropland and water salvage could increase downstream outflow. Net effect of salvage, land conversion and reservoir construction on outflow is shown below:

	Net effect on outflow
Increase in water surface evaporation, net	140 acre-feet
Increase in consumptive use, croplands	8,400 acre-feet
Decrease in consumptive use, wetlands	11,190 acre-feet
Total increase in outflow	2,650 acre-feet

Water quality would be improved by retention of 4 acre-feet of sediment annually.

Development measures described in Watershed A-3 could eliminate the existing consumptive use deficit of 1,730 acre-feet. Also, land use conversion would increase consumptive use on croplands by 1,180 acre-feet and decrease consumptive use on wetlands by 1,270 acre-feet. Water salvage from wetlands not converted is estimated at 230 acre-feet.

In Watershed A-4, net water gained from the difference in present consumptive use on the wet meadows and that expected from the pasture-cropland conversion would be available for use within the watershed and for downstream users as shown below:

	Net effect on downstream flow
Increased consumptive use, croplands	3,520 acre-feet
Decreased consumptive use, wetlands	11,950 acre-feet
Net increase in downstream flow	8,430 acre-feet

Water quality could be improved by the annual retention of 5 acre-feet of sediment from Manti Canyon.

Sub-basin development could eliminate the present irrigation water shortage of 13,750 acre-feet. Conversion of 5,000 acres of wetlands to irrigated rotated cropland could reduce consumptive use by 920 acre-feet. Water salvage in wetland areas of 24,620 acre-feet could result by lowering the water table. The net result of all development measures in Sub-basin A is an increase in outflow of 12,010 acre-feet to Sub-basin C (Table 41).

Alternative Development Opportunities There are six potential reservoir sites with a total capacity of nearly 35,000 acre-feet that could be

TABLE 41.--Hydrologic effects of Early Action Program, Sub-basin A, Sevier River Basin

Item	Present	Early Action[a]	Difference
	Ac. ft.	Ac. ft.	Ac. ft.
Consumptive use deficit	13,750	0	-13,750
Surface water diversions	144,610	154,380	+ 9,770
Well diversions	14,240	44,520	+30,280
Total diversions[b]	158,850	198,900	+40,050
Tributary inflow	169,680	169,680	0
Precipitation on cropland	50,240	54,890	+ 4,650
Precipitation on wetland	40,640	36,340	- 4,300
Total water available	260,560	260,910	+ 350
Actual consumptive use on cropland	110,300	135,820	+25,520
Consumptive use on wetland	121,250	83,930	-37,320
Reservoir water surface evaporation, net	0	140	+ 140
M&I use and cropland water surface evaporation	5,150	5,150	0
Total water use[b]	236,700	225,040	-11,660
Total outflow[c]	23,860	35,870	+12,010

[a]Early Action program conditions include increased irrigation efficiencies from all development measures including on-farm land treatment practices.

[b]Total diversions and total water used do not reflect an irrigation efficiency. The effects of direct use from groundwater are not shown on this summary.

[c]Total outflow=Total water available-Total water use.

developed for flood prevention, irrigation water storage and recreation. Two of these, the Narrows and Moroni sites, have a combined capacity of over 30,000 acre-feet. In addition, there are sites in Ephraim Canyon, Willow Creek, New Canyon, Manti Canyon and one each near Milbourn and Spring City. Also, there is the possibility of increasing the capacity of Funks Lake.

More intensive groundwater salvage and on-farm practices should be considered as alternatives to structural development. Stabilization of transmountain diversions or supplemental development of additional water to eliminate this need should be considered.

Sub-basin C (Lower Sevier Valley)

Early Action Program developments include four multiple-purpose reservoirs and one evaporation basin.

Groundwater reservoir storage capacity is 650,000 acre-feet in the upper 200 feet of alluvium with a management potential of 65,000 acre-feet. Consumptive use by phreatophytes could be reduced to salvage 21,100 acre-feet of water. Present groundwater use averages 1,180 acre-feet (Tables 42, 43 and 44).

Watershed C-3 (Gunnison-Sterling) A reservoir on Six Mile Creek could provide 880 acre-feet of irrigation water storage and 220 acre-feet of flood and sediment storage. Irrigation storage and flood prevention benefits would provide $8,050 and $720, respectively. Approximately two miles of improved fish habitat below the dam would provide annual benefits of $2,280. Incidental recreation benefits are $1,000 annually. A conservation pool in this reservoir should be considered.

Shallow irrigation wells could be used to salvage water presently being consumed by phreatophytes. Twenty-two wells; ten in Watershed C-1, eight in Watershed C-2 and four in Watershed C-3 could provide a net salvage of 5,530 acre-feet of water. This would also allow conversion of 1,700 acres of wetlands and 6,200 acres of nonrotated cropland to rotated cropland. Benefits are estimated to be $192,130.

Watershed C-6 (Lost Creek) Approximately 9,900 acres of cropland immediately below the confluence of Lost Creek and the Sevier River are affected by salt buildup deposited through irrigation. An evaporation basin on Lost Creek was evaluated to reduce the dissolved solids delivered to the river system. This off-channel structure could store late irrigation season return flows of less than one cubic foot per second when the salt content is the highest. Flood and early snowmelt flows would be bypassed. Retention of approximately nine acre-feet of salt annually will yield benefits of $79,980.

Watershed C-5 (Salina Creek) Sediment yield from this watershed averages 0.46 acre-feet per square mile with an annual volume of 130 acre-feet carried by Salina Creek. Also, there is an average root-zone water shortage of 220 acre-feet coupled with a 3,700 acre-foot loss to groundwater from irrigation and distribution inefficiencies.

Enlargement of the present Skutumpah Reservoir could provide 450 acre-feet of sediment storage, restore 500 acre-feet of irrigation water storage and create a fishery with a surface area of 44 acres. Rapid erosion of the water delivery system and surrounding drainage into Skutumpah Reservoir is producing a high

TABLE 42.--Water resource structural development, Sub-basin C, Early Action Program, Sevier River Basin, Utah

Development	Unit	Development opportunities			Program application			
		Existing	Potential	Needed	Going	Accel-erated	Early Action	Total
Sediment storage	Acre-feet	[b]	18,080	13,000	-	-	10,830	10,830
Floodwater								
Storage	Acre-feet	[b]	4,530	3,800	-	-	3,120	3,120
Channel	Mile	10	15	3	-	-	-	-
Irrigation water								
Storage	Acre-feet	261,780	25,730[a]	10,000	-	-	5,380	5,380
Regulation	Acre-feet	-	8,000	5,000	-	-	4,000	4,000
Canal lining	Mile	10	265	185	5	10	-	15
Recreation								
Water storage	Acre-feet	[b]	2,000	1,000	-	-	690	690
Water surfaces	Acre	12,920	300	290	-	-	280[c]	280
Streamflow	Mile	[b]	90	55	-	-	2	2
Total recreation use	Visitor-day	[b]	[b]	[b]	-	-	26,000	26,000

[a]Does not include possible enlargement of Gunnison Reservoir.

[b]Not evaluated.

[c]Utilizes 150 acres of the Salina (C5-8) site sediment pool as it fills.

Note: Refer to Tables 50 to 53 for physical and economic data.

TABLE 43.--Salvage and management of groundwater, Sub-basin C, Early Action Program, Sevier River Basin, Utah

Watershed[a]	Salvage		Groundwater management	Area affected
	Gross	Net		
	Ac. ft.	Ac. ft.	Ac. ft.	Acres
C-1	8,890	3,690	23,500	6,990
C-2	5,750	870	19,000	5,330
C-3	3,330	970	9,100	3,730
C-5	3,130	610	13,400	2,190
Total	21,100	6,140	65,000	18,240

TABLE 44.--Economic evaluation of groundwater development, Sub-basin C, Early Action Program, Sevier River Basin

Watershed[a]	Wells	Costs		Annual benefits	Benefit-cost ratio
		Total	Annual		
	No.	Dollars	Dollars	Dollars	
C-3	22	329,230	46,430	231,810	5.0:1
C-5	6	89,770	12,280	47,350	3.9:1
Total	28	419,000	58,710	279,160	4.8:1

[a]Watersheds C-1, 2 and 3 were analyzed as one evaluation unit.

rate of sedimentation to the site. Feasibility of reservoir enlargement will be dependent upon stabilization of sediment sources. Annual benefits are $2,730, $3,210 and $3,830, respectively.

Construction of Bull Pasture Reservoir could provide 1,420 acre-feet of sediment storage with annual benefits of $7,670; 4,000 acre-feet of irrigation storage with annual benefits of $36,600, and 540 acre-feet of recreation storage with annual benefits of $9,340. Salina Reservoir, just above the town of Salina, could provide 7,920 acre-feet of sediment storage. Portions of this storage could be used for recreation and to regulate irrigation water as the sediment pool fills. Consideration should be given to using Skutumpah and Bull Pasture Reservoirs for recreation and flood control only or at least minimizing the fluctuations in water levels. Annual benefits are $44,380, $26,160 and $660, respectively.

Six shallow wells installed within the wetland areas could provide drainage, salvage water and help maintain the flow of the Sevier River downstream. These wells would allow conversion of 1,300 acres of irrigated nonrotated cropland and 200 acres of wetlands to irrigated rotated cropland. Benefits are estimated to be $38,570.

Hydrologic Interrelationships Water quality in Sub-basin C will be increased through reduced sediment as follows: Watershed stabilization, 47 acre-feet; Blue Meadow Reservoir, 2 acre-feet; Lost Creek evaporation basin, 9 acre-feet; and Skutumpah, Bull Pasture and Salina Reservoirs, 98 acre-feet for a total of 156 acre-feet.

Blue Meadow Reservoir on Six Mile Creek would alter the flow pattern of the river on a monthly basis and the annual flow would be reduced by the net water surface evaporation of 30 acre-feet. The net effect of satisfying present root-zone water shortages of 7,660 acre-feet and converting 6,200 acres of irrigated nonrotated cropland and 1,700 acres of wetlands in Watersheds C-1, 2 and 3 to irrigated rotated cropland is estimated as follows:

	Net effect on downstream flows
Increased net water surface evaporation	30 acre-feet
Increased irrigated land consumptive use	12,100 acre-feet
Decreased wetland consumptive use	4,550 acre-feet
Total decrease in available supply	7,580 acre-feet

The Lost Creek evaporation basin would reduce flows by an annual evaporation of 400 acre-feet. Present average annual root-zone water shortages in Watersheds C-4 and C-6 of 620 and 810 acre-feet, respectively, could be eliminated by increased diversions and improvements of on-farm systems. The reservoirs in Watershed C-5 alter the flow pattern of the river considerably on a monthly basis.

Net effect of development measures in Watersheds C-4, C-5 and C-6 on downstream flow follows:

	Net effect on downstream flow
Increase in net water surface evaporation	1,570 acre-feet
Increased irrigated land consumptive use	2,180 acre-feet
Decreased wetland consumptive use	820 acre-feet
Decrease in available supply	2,930 acre-feet

Water salvage on nonconverted wetlands within Sub-basin C could amount to 9,150 acre-feet which could be used to eliminate existing water shortages and provide a partial supply to converted lands.

The annual water-budget values for the 1931-1960 base period and the changes resulting from the Early Action development measures described are shown in Table 45.

TABLE 45.--Hydrologic effects of Early Action Program, Sub-basin C, Sevier River Basin

Item	Present	Early Action[a]	Difference
	Ac. ft.	Ac. ft.	Ac. ft.
Consumptive use deficit	9,090	0	- 9,090
Surface water diversion	177,560	183,440	+ 5,880
Well diversion	1,180	10,000	+ 8,820
Total diversions[b]	178,740	193,440	+14,700
Surface water inflow	139,860	156,110	+16,250
Groundwater inflow	14,000	6,000	- 8,000
Tributary inflow	115,130	115,130	0
Precipitation on cropland	45,140	46,940	+ 1,800
Precipitation on wetland	12,110	10,310	- 1,800
Total available water	326,240	334,490	+ 8,250
Actual consumptive use on cropland	109,200	123,480	+14,280
Consumptive use on wetlands	44,930	30,410	-14,520
Reservoir water surface evaporation, net	4,670	6,270	+ 1,600
M&I use and cropland water surface evaporation	4,220	4,220	0
Net evaporation Sevier Bridge Reser.	22,840	22,840	0
Total water use[b]	185,860	187,220	+ 1,360
Total outflow[c]	140,380	147,270	+ 6,890

[a]Early Action program conditions include increased irrigation efficiencies from all development measures including on-farm land treatment practices.

[b]Total diversions and total water used do not reflect an irrigation efficiency. The effects of direct use from groundwater are not shown on this summary.

[c]Total outflow=Total water available-Total water use.

Alternate Development Opportunities Alternative development measures include additional structures for sediment reduction on Soldier Canyon, Rattlesnake Point, Taylors Flat, Blackberry and Tipparary Canyon with a combined capacity of 9,200 acre-feet. Blackberry Reservoir could also provide storage for recreation. An alternate approach to improve irrigation water use efficiency could include lining of the Highland Canal and Piute Canal.

Enlargement of Gunnison Reservoir is another alternative. This would require extensive investigation and coordination with water users in Sub-basin A.

Sub-basin B (Sevier Desert)

Water resource developments include 4 multiple-purpose reservoirs with a total capacity of 8,000 acre-feet, 65 miles of canal lining, and 14 miles of pipelines (Table 46). Total impact of all development measures would increase the total outflow into Sevier Lake by 14,430 acre-feet and the outflow into the Chalk Creek Watershed by 3,920 acre-feet.

The groundwater reserves in the Sevier Desert include layers of fresh water and slightly saline water with the best quality water at the lower depths. The groundwater management potential is estimated to be 82,000 acre-feet. Separate research defines a safe yield of 58,000 acre-feet of water which could be withdrawn from groundwater reservoirs in Watersheds B-5 and 7. Since the initial water-budgets were prepared, a number of wells have been installed. These wells are now pumping 40,000 acre-feet of water annually. Total water salvage in Sub-basin B is estimated at 27,570 acre-feet (Tables 47 and 48).

Watersheds B-1 and B-2 (Levan) The average annual root-zone water shortage is 4,320 acre-feet. The shortage is due to low irrigation efficiencies and lack of storage to retain early season runoffs. The latter could be improved by regulatory storage.

Three reservoir sites were investigated having a total regulating storage capacity of 1,655 acre-feet. This storage is allocated to flood protection, sediment retention, recreation and irrigation. Floodwater and sediment storage in the three reservoirs could produce combined average annual benefits of $18,130. Regulatory storage benefits in all three sites are estimated at $17,560. Recreation opportunities exist at each of the reservoir sites. Total annual benefits are estimated at $22,700.

The Levan Irrigation Company could line approximately 16 miles of canal through high seepage areas. Benefits were estimated at $19,800.

Fourteen miles of pipeline could develop irrigation water in Deep, Little Salt, and Criss Creeks by moving existing points of diversion upstream to reduce the high water loss in the stream channels. Inlet structures would be included as part of the construction. Annual benefits would be $22,070.

Full development of water resources in the Mills area could be accomplished by draining the Juab Lake (Chicken Creek) Reservoir and surrounding wetlands with 27 wells. This would require the Juab Lake Irrigation Company to change from their present water source to utilization of the groundwater reservoir. Water salvaged from the wet areas would be available for use within the watershed and help offset the downstream impacts. Developments described would decrease the outflow to the Sevier River by 160 acre-feet annually. Benefits amount to $71,800 annually.

TABLE 46.--Water resource structural development, Sub-basin B, Early Action Program, Sevier River Basin, Utah

Development	Unit	Development opportunities			Program application			
		Existing	Potential	Needed	Going	Accel-erated	Early Action	Total
Sediment storage	Ac. ft.	-	800	700	-	-	225	225
Floodwater								
Storage	Ac. ft.	[a]	500	450	-	-	390	390
Channel	Mile	-	10	5[b]	-	-	-	-
Irrigation water								
Storage	Ac. ft.	36,150	7,000	6,800	-	-	6,300	6,300
Regulation	Ac. ft.	272,300	2,000	1,500	-	-	30	30
Canal lining	Mile	105	340	235	15	30	78	123
Recreation								
Water storage	Ac. ft.	[a]	1,200	1,200	-	-	1,035	1,035
Water surface	Acre	5,340	150	100	-	-	80	80
Streamflow	Mile	6	22	10	-	-	-	-
Total recreation use	Visitor-day	[a]	[a]	[a]	-	-	22,830	22,830

[a]Not evaluated.

[b]Not needed with flood prevention storage.

Note: Refer to Tables 50 to 53 for physical and economic data.

TABLE 47--Salvage and management of groundwater, Sub-basin B, Early Action Program, Sevier River Basin

Watershed	Salvage[a]	Groundwater management	Area affected
	Ac. ft.	Ac. ft.	Ac. ft.
B-1 and 2	3,990	10,000	1,180
B-4	4,500	-	510
B-6	4,000	22,000	980
B-7	15,080	50,000	24,990
Total	27,570	82,000	27,660

[a]Salvage from groundwater and decreases in water surface evaporation.

TABLE 48.--Economic evaluation of groundwater development, Sub-basin B, Early Action Program, Sevier River Basin

Watershed	Wells	Costs		Annual benefits	Benefit-cost ratio
		Total	Annual		
	No.	Dollars	Dollars	Dollars	
B-1 and 2	27	593,900	35,050	87,910	2.5:1
B-6 and 7	45	1,665,000	203,570	704,480	3.5:1
Total	72	2,258,900	238,620	792,390	3.3:1

Watershed B-4 (Scipio) The average annual root-zone water shortage is 2,790 acre-feet, or approximately one-third the potential consumptive use. Irrigation water supplies are short nine years out of ten. High seepage losses in the irrigation distribution system, and use of water by phreatophytes and water surface evaporation in the Scipio Lake Reservoir area contribute to the inefficient use of the water resource.

Abandoning the Scipio Lake Reservoir and draining the surrounding wet meadows could reduce consumptive use in this area and supply 70 percent more water for irrigation. Four miles of drain would be required to lower the water table. Replacement of the present reservoir with one nearer to Scipio would provide better control of the irrigation supply with 5,040 acre-feet of regulatory storage. Benefits are estimated at $77,930. The close proximity to U.S. 91 and proposed I-15 would insure substantial use of a water-based recreational development with an additional 110 acre-feet of storage for this purpose. Annual benefits would amount to $11,550.

Lining the entire 35 miles of the irrigation water distribution system from Scipio Reservoir could reduce seepage losses and annual maintenance costs. Developments would increase the groundwater outflow by 1,710 acre-feet. Benefits amount to $44,910 annually.

Watersheds B-5, B-6 and B-7 (Lynndyl-Holden-Delta) Annual root-zone water shortages are 36,700 acre-feet. This shortage has been reduced by 19,000 acre-feet during the last few years by installing wells resulting in an estimated current shortage of 17,700 acre-feet.

The Early Action Program evaluated lining 13.4 miles of the upper portion of the Central Utah Canal and abandoning the canal between the Lynndyll siphon and the McCormick-Greenwood area. Irrigation water for the McCormick-Greenwood area would be supplied by wells. The annual river diversion could be reduced from 30,000 acre-feet to 16,180 acre-feet providing additional water for downstream use. Increased efficiencies from lining the Central Utah Canal would save 2,090 acre-feet providing $73,150 in benefits. Fool Creek reservoirs are inefficient and most of the water is evaporated or lost to phreatophytes.

Early Action Program development includes 45 wells; 17 in Watershed B-6 (McCormick-Greenwood area) and 28 in Watershed B-7 (Delta area). These wells would provide $560,000 in annual benefits.

Hydrologic Interrelationships Sediment reduction includes retention of 27 acre-feet annually by structures in Watersheds B-1 and B-2 as well as 23 acre-feet annually through watershed stabilization throughout Sub-basin B.

Reservoirs in Watersheds B-1 and B-2 would reduce annual flows from Chicken and Pigeon Creeks by 290 acre-feet through increased water surface evaporation. Elimination of the existing Juab Lake (Chicken Creek) Reservoir water surface evaporation of 1,800 acre-feet and reduction of consumptive use on wetlands could partially offset increased consumptive use on cropland. Net effects of development measures on outflow are shown below:

	Net effect on downstream flow
Decrease in water surface evaporation	1,510 acre-feet
Increased cropland consumptive use	4,150 acre-feet
Decreased wetland consumptive use	2,480 acre-feet
Decrease in outflow from Watersheds B-1 and B-2	160 acre-feet

Eliminating the existing Scipio Lake Reservoir in Watershed B-4 in favor of a site downstream should decrease water surface evaporation

by 3,600 acre-feet and consumptive use on wetlands by 500 acre-feet. Net effects of development measures on outflow is shown below:

	Net effect on outflow
Decreased net water surface evaporation	3,600 acre-feet
Decreased wetland consumptive use	900 acre-feet
Increased cropland consumptive use	2,790 acre-feet
Increase in outflow from Watershed B-4	1,710 acre-feet

Groundwater studies indicate that the management potential in Watersheds B-6 and 7 (the Sevier Desert and Pavant Valley) is 82,000 acre-feet. Well development since the 1931-1960 period has reached 10,000 acre-feet in Watershed B-6 and 30,000 acre-feet in Watershed B-7. Consumptive use deficits have been reduced by 19,000 acre-feet. Additional well development in B-6 and 7 could provide 12,000 acre-feet and 20,000 acre-feet, respectively, to eliminate consumptive use deficits of 11,990 acre-feet and increase the outflow to Chalk Creek by 9,080 acre-feet.

Upstream improvements indicate an increased inflow into Sub-basin B of 6,890 acre-feet. Salvage by watershed is:

B-1 and 2	3,990 acre-feet
B-4	4,500 acre-feet
B-6	4,000 acre-feet
B-7	15,080 acre-feet

The effect of all developments in Sub-basin B is shown in Table 49. Items, as noted, have been adjusted to reflect developments since the 1931-1960 average conditions. Fool Creek Reservoir was eliminated for the Early Action part of the water-budget with a savings in consumptive use and evaporation of 4,580 acre-feet.

Alternate Development Opportunities In Watersheds B-1 and B-2, Juab Lake Reservoir could be reduced in size and retained for recreation and wildlife purposes. Other reservoirs could be managed to provide greater recreation opportunities.

Alternate development proposals in Watershed B-4 include (1) Installation of a pipeline to distribute water below the proposed reservoir and sprinkler irrigation, (2) eliminate water salvage or construction of a new reservoir, and (3) preservation of waterfowl habitat by retaining a smaller lake at the present site.

TABLE 49.--Hydrologic effects of Early Action Program, Sub-basin B, Sevier River Basin

Item	Present	Early Action[a]	Difference
	Ac. ft.	Ac. ft.	Ac. ft.
Consumptive use deficits[g]	24,810	170	-24,640
Diversion to Central Utah Canal	42,190	16,180	-26,010
Surface water diversion[b]	174,920	208,660	+33,740
Well diversion	49,350[e]	97,090	+47,740
Total diversions[c]	224,270	305,750	+81,480
River inflow	140,380	147,270	+ 6,890
Tributary inflow	103,350	103,350	0
Inflow from Clear Lake Spring	15,230	15,230	0
Precipitation on cropland	64,930	64,930	0
Precipitation on wetland and water surfaces	89,570	89,570	0
Total water available	413,460	420,350	+ 6,890
Fool Creek Reservoir, net water use	4,580	0	- 4,580
Actual consumptive use on cropland	183,910[f]	208,550	+24,640
Consumptive use on wetland	197,410	174,950	-22,460
Reservoir water surface evaporation, net	5,800	690	- 5,110
Total water use[c]	394,610	387,100	- 7,510
Outflow to Sevier Lake	13,690	24,170	+10,480
Outflow to Central Utah Canal	5,160	9,080	+ 3,920
Total outflow[d]	18,850	33,250	+14,400

[a]Early Action program conditions include increased irrigation efficiencies from all development measures including on-farm land treatment practices.

[b]Includes Central Utah Canal diversions shown above.

[c]Total diversions and total water used do not reflect an irrigation efficiency. The effects of direct use from groundwater are not shown on this summary.

[d]Total outflow-Total water available-Total water use.

[e]"Present" condition of 9,350 acre-feet revised to show present developments above 1931-1960 average conditions.

[f]Increased 19,000 acre-feet over 1931-1960 average conditions to reflect root-zone water from increased pumping of 40,000 acre-feet.

[g]Decreased by 19,000 acre-feet from 1931-1960 average conditions.

An alternative for the Central Utah Canal in Watershed B-5 and B-6 was investigated which would eliminate the canal below Lynndyl siphon with lower water users supplied winter water stored in DMAD Reservoir. This would reduce the need for pumping in Watershed B-6.

Additional salvage of the shallow groundwater used by phreatophytes in the Delta area is possible. This water is generally of a poor quality and would have questionable benefits.

Tabular Summary

Tables 50 and 51 summarize the physical data of the structural measures evaluated for the Early Action Program. The cost allocations and economic evaluations are shown in Tables 52 and 53. Benefits and costs were based on a general reconnaissance using PL-566 Watershed Planning criteria. Table 54 shows a suggested installation schedule of structural developments.

ON-FARM DEVELOPMENTS

On-farm land treatment measures coordinated with other development programs is a significant part of the Early Action Program. Land leveling or sprinkler systems have been applied on 73,000 acres and 187,000 acres need application. Ditch lining or pipelines have been installed on 125 miles and 1,890 miles need to be installed.

By 1985, 47,200 acres of land leveling or sprinkler systems and 400 miles of ditch lining or pipelines need to be applied under accelerated programs. This is in addition to approximately 84,250 acres of land leveling or sprinkler systems and 815 miles of ditch lining or pipelines that will be applied under going programs at the present application rate. Accelerated land treatment measures during the Early Action period cost $8,525,000 of which $4,200,000 will be from federal sources. Annual benefits are $1,343,220 and costs are $723,810.

Going programs should adequately meet the needs for drainage not accomplished through groundwater management, farm reservoirs, field ditches, and other on-farm land treatment measures. The installation of needed practices by going and accelerated programs increases overall basin irrigation efficiency about 4 percent.

Approximately 2,430 new or revised conservation plans are needed under accelerated programs to assure proper application of land treatment measures. Cost is estimated at $305,000 (Tables 55 and 56). With the acceleration of project activity through the Early Action Program, requests for financial and technical assistance will be greatly increased.

TABLE 50.-- Summ

Projects	rage capacity[c]				Recreation	
	Flood sion	Irrigation	Recreation	Total storage	Campgrounds	Visitor-days
	t.	Ac. ft.	Ac. ft.	Ac. ft.	Each	Each
Hatch (F5-1)	0	3,600	-	18,000	-	17,850
Red Canyon (F2-	0	-	-	700	-	790
Casto Canyon (F	0	-	-	760	-	800
Panguitch (F3-1	5	75	150	500	1	3,130
Circleville Can	0	-	1,800	4,000	-	9,240
Tropic (E5-1)[h]	0	200	-	400	-	-
Upper Antimony	0	-	230	950	-	6,320
Koosharem (E1-1		600	-	600	-	3,230
Flat Canyon (D1	0	-	-	1,700	-	-
Cottonwood (D1-	0	-	-	1,800	-	-
Big Hollow (A2-	5	1,425	-	2,200	-	880
Manti (A4-2)	0	-	-	310	1	1,470
Blue Meadow (C3	0	880	-	1,100	-	670
Lost Creek (C6-	0	-	-	1,000	-	-
Bull Pasture (C	0	4,000	540	6,160	1	6,230
Skutumpah (C5-5	0	500	150	1,360	1	2,550
Salina (C5-8)	0	-	-	10,400	1	17,440
Upper Chicken C	0	1,200	660	1,940	1	9,330
Pigeon Creek (B	5	10	150	455	1	2,900
Lower Chicken C	0	20	115	455	1	2,900
New Scipio (B4-		5,040	110	5,150	1	7,700

[a]All prin

[b]Percent

[c]Tentativ

[d]Structur ways or railroads.

[e]Structur erruption of use or service of relatively important utilities.

[f]Freeboar

[g]Sediment

[h]Reservoi

[i]Structur

TABLE 50.--Summary of reservoir data, Early Action Program, Sevier River Basin

Projects	Class of structure	Drainage area	Height of dam	Volume of fill	Structure life	Principal spillway release rate[a]	Emergency spillway		Surface area		Storage capacity[c]						Recreation	
							Type	Chance of use[b]	Recreation pool	Emergency spillway level	Sediment	Flood	Total flood prevention	Irrigation	Recreation	Total storage	Campgrounds	Visitor-days
		Sq. mile	Feet	Cu. yd.	Year	csm		Percent	Acre	Acre	Ac. ft.	Ac. ft.	Ac. ft.	Ac. ft.	Ac. ft.	Ac. ft.	Each	Each
Hatch (F5-1)	c	311.0	75	740,000	100	6	Earth	1	-	650	9,400	5,000	14,400	3,600	-	18,000	-	17,850
Red Canyon (F2-1)	a[i]	17.0	50	175,000	50	10	Earth	2	-	30	560	140	700	-	-	700	-	790
Casto Canyon (F2-2)	a[i]	20.0	50	190,000	50	10	Earth	2	-	30	600	160	760	-	-	760	-	800
Panguitch (F3-1)	c	61.0	45	110,000	50	10	Concrete	2	17	34	50	225	275	75	150	500	1	3,130
Circleville Canyon (F1-1)	c	981.0	55	175,000	50	0.5	Concrete	2	140	200	1,700	500	2,200	-	1,800	4,000	-	9,240
Tropic (E5-1)[h]	b	87.5	29	27,500	100	10	Concrete	50	-	185	200	-	200	200	-	400	-	-
Upper Antimony (E3-2)	c	90.0	75	287,000	100	2	Concrete	50	16	22	450	270[f]	720	-	230	950	-	6,320
Koosharem (E1-1)[h]	c	110.0	35	25,000	100	2	Earth	1	-	500	-	-	-	600	-	600	-	3,230
Flat Canyon (D1-1a)	c	15.8	25	400,000	100	10	Earth	1	-	55	1,100	600	1,700	-	-	1,700	-	-
Cottonwood (D1-5)	c	19.8	75	335,000	100	10	Earth	1	-	40	1,200	600	1,800	-	-	1,800	-	-
Big Hollow (A2-1)	c[d]	22.7	85	566,500	100	13	Concrete	1	-	65	405	370	775	1,425	-	2,200	-	880
Manti (A4-2)	b[e]	13.0	40	80,000	50	10	Concrete	2	-	15	260	50[f]	310	-	-	310	1	1,470
Blue Meadow (C3-1)	b	8.0	70	200,000	50	10	Earth	2	-	50	100	120	220	880	-	1,100	-	670
Lost Creek (C6-1)	b	2.0	25	230,000	100	5	Earth	1	-	100	940	60	1,000	-	-	1,000	-	-
Bull Pasture (C5-4)	c	14.2	75	100,000	100	10	Concrete	2	76	76	1,420	200[e]	1,620	4,000	540	6,160	1	6,230
Skutumpah (C5-5)	c	8.9	45	40,000	100	10	Concrete	2	44	54	450	260[f]	710	500	150	1,360	1	2,550
Salina (C5-8)	c	292.4	70	675,000	100	4.3	Concrete	1	-	306	7,920	2,480[f]	10,400	-	-	10,400	1	17,440
Upper Chicken Creek (B1-1)	c	8.0	80	95,500	50	1.3	Rock	1	39	92	-	-	80	1,200	660	1,940	1	9,330
Pigeon Creek (B1-2)	c	9.5	50	119,500	10[g]	31.6	Rock	1	12	20	111	184	295	10	150	455	1	2,900
Lower Chicken Creek (B1-3)	c	16.6	50	119,500	10[g]	18.1	R/C conduit	1	12	20	115	205[f]	320	20	115	455	1	2,900
New Scipio (B4-1)	c	27.0	80	1,050,000	100	1.9	Rock	1	18	140	-	-	-	5,040	110	5,150	1	7,700

[a]All principal spillways were designed using reinforced concrete conduits.

[b]Percent chance of use based on 100-year period, i.e. one percent chance would be a frequency of use of once every 100 years.

[c]Tentative capacities based upon preliminary investigations and the proposed structure use.

[d]Structure located where failure might cause loss of life, serious damage to homes, industrial and commercial buildings, important public utilities, main highways or railroads.

[e]Structure located in predominantly rural or agricultural areas, where failure may damage isolated homes, main highways or minor railroads or might cause interruption of use or service of relatively important utilities.

[f]Freeboard storage.

[g]Sediment retention capacity for ten years.

[h]Reservoir enlargement.

[i]Structure located in rural or agricultural areas, where failure may damage farm buildings, agricultural land or township and country roads.

TABLE 51.--Summary of other structural measures, Early Action Program, Sevier River Basin, Utah

Watershed	Canal lining		Pipeline		Wells[b]		Drains	Sprinkling system	Channel improvement	Recreation development	
	Length	Capacity	Length	Capacity	Number	Yield	Length	Length	Length	Number	Area surface
	Miles	CFS[a]	Miles	CFS	Each	Ac.Ft.	Miles	Miles	Miles	Each	Acres
F-2	16	95			9	2,835					
F-3	18	17-50			3	945			2		
F-1	19	10-60			11	3,460					
E-5	4	10	.3	10							
E-3					5	1,565		11			
E-1					11	3,440					
D-8	8.25	15			5	1,580					
D-1	72	17-560			14	4,425					
D-2 and 3			14.5	2	12	3,795					
A-1	55	5-40	38	5-25	30	9,770			.5	3	672[c]
A-2	21	10-20	3	1	26	8,465					
A-3	75	10-85			9	2,930					
A-4	11	10-45			28	9,115					
C-3					4	1,215					
C-1					10	3,045					
C-2					8	2,435					
C-5					6	1,825					
B-1 and 2	16	8	14	3-8	27	8,125					
B-4	35	10-40					4				
B-5, 6 and 7	13.4	80-300			45	32,000					

[a]Variable capacities shown are due to the number of irrigation systems in a watershed, total length includes main canals plus smaller laterals or main canals reduced in capacity from upper end to lower end.

[b]Shallow wells pumping at a rate of 2 cfs with a lift of 50 feet or less.

[c]Includes two fisheries and a waterfowl development not associated with a reservoir installation.

TABLE 52.--Structural development, cost allocation and cost sharing, Early Action Program, Sevier River Basin, Utah[a]

	Cost allocation purpose				Cost-sharing							
					Federal				Non-federal			
	Flood				Flood				Flood			
Manti Irrigation Co.			163,280	163,280			90,330	90,330			72,950	72,950
North Six Mile Irrigation Co.			47,920	47,920			26,470	26,470			21,450	21,450
Manti Irrigation & Reservoir Co.			52,630	52,630			29,080	29,080			23,550	23,550
Wells			363,770	363,770			37,080	37,080			326,690	326,690
Manti Debris Basin (A4-2)	235,400			235,400	235,200			235,200	200			200
Water-based recreation		15,730		15,730		8,680		8,680		7,050		7,050
Watershed C-3 (Gunnison)												
Blue Meadow Reservoir (C3-1)	67,800		271,200	339,000	67,600		150,400	218,000	200		120,800	121,000
Wells (C-1, 2 and 3)			329,230	329,230			29,870	29,870			299,360	299,360
Watershed C-6 (Lost Creek)												
Lost Creek evaporation basin (C6-1)			436,000	436,000			231,000	231,000			205,000	205,000
Watershed C-5 (Salina Creek)												
Bull Pasture Reservoir (C5-4)	118,060	44,270	329,570	491,900	110,140	22,970	170,940	304,050	7,920	21,300	158,630	187,850
Water-based recreation		32,100		32,100		17,800		17,800		14,300		14,300
Skutumpah Reservoir (C5-5)	43,620	14,900	47,880	106,400	34,600	6,570	21,100	62,270	9,020	8,330	26,780	44,130
Water-based recreation		8,800		8,800		4,800		4,800		4,000		4,000
Salina Reservoir (C5-8)	981,510	400,890		1,382,400	795,770	180,560		976,330	185,740	220,330		406,070
Water-based recreation		133,400		133,400		51,900		51,900		81,500		81,500
Wells			89,770	89,770			8,130	8,130			81,640	81,640
Watersheds B-1 and 2 (Levan-Mills)												
Reservoirs	98,400	135,300	176,300	410,000	98,280	75,080	97,820	271,180	120	60,220	78,480	138,820
Canal lining			203,500	203,500			113,000	113,000			90,500	90,500
Pipelines			213,500	213,500			118,550	118,550			94,950	94,950
Wells			593,900	593,900			36,300	36,300			557,600	557,600
Water-based recreation		47,350		47,350		26,300		26,300		21,050		21,050
Watershed B-4 (Scipio)												
Canal lining			523,450	523,450			290,750	290,750			232,700	232,700
Drainage			441,100	441,100			32,900	32,900			408,200	408,200
Reservoir		19,200	874,600	893,800		10,600	483,800	494,400		8,600	390,800	399,400
Water-based recreation		21,200		21,200		11,100		11,100		10,100		10,100
Watersheds B-5, 6 and 7 (Lyndyll-Holden-Delta)												
Central Utah canal lining			889,750	889,750			488,750	488,750			401,000	401,000
Wells			1,665,000	1,665,000			180,000	180,000			1,485,000	1,485,000
GRAND TOTAL	6,118,520	1,705,560	19,605,890	27,429,970	5,755,760	786,110	8,175,330	14,717,200	362,760	919,450	11,430,560	12,712,770

[a]Price base 1967.

TABLE 52.--Structural development, cost allocation and cost sharing, Early Action Program, Sevier River Basin, Utah[a]

	Cost allocation purpose				Cost-sharing							
					Federal				Non-federal			
	Flood prevention	Recreation	AWM	Total	Flood prevention	Recreation	AWM	Total	Flood prevention	Recreation	AWM	Total
Watershed F-5 (Hatch)												
Hatch Reservoir (F5-1)	1,428,000		357,000	1,785,000	1,412,000		196,000	1,608,000	16,000		161,000	177,000
Watershed F-2 (Panguitch Valley)												
Red Canyon Debris Basin (F2-1)	298,000			298,000	293,000			293,000	5,000			5,000
Casto Canyon Debris Basin (F2-2)	322,000			322,000	321,000			321,000	1,000			1,000
Canal lining			718,000	718,000			398,500	398,500			319,500	319,500
Wells			139,510	139,510			12,510	12,510			127,000	127,000
Watershed F-3 (Panguitch Creek)												
Panguitch Creek Reservoir (F3-1)	81,810	44,630	22,310	148,750	77,000	23,250	11,620	111,870	4,810	21,380	10,690	36,880
Panguitch Creek channel improvement	26,780			26,780	25,200			25,200	1,580			1,580
Water-based recreation		20,380		20,380		11,000		11,000		9,380		9,380
Canal lining			300,550	300,550			166,320	166,320			134,230	134,230
Wells			46,490	46,490			4,160	4,160			42,330	42,330
Watershed F-1 (Circleville)												
Circleville Canyon Reservoir (F1-1)	324,500	265,500		590,000	214,500	97,420		311,920	110,000	168,080		278,080
Canal lining			336,100	336,100			186,000	186,000			150,100	150,100
West Circle Valley canal (F-1 and D-8)			127,000	127,000			70,000	70,000			57,000	57,000
Wells			198,500	198,500			19,630	19,630			178,870	178,870
Watershed E-5 (Tropic)												
Tropic Reservoir enlargement (E5-1)			30,900	30,900			17,000	17,000			13,900	13,900
Pipeline			15,780	15,780			8,680	8,680			7,100	7,100
Canal lining			115,460	115,460			63,860	63,860			51,600	51,600
Watershed E-3 (Antimony)												
Antimony Creek Reservoir (E3-2)	243,300	243,300		486,600	242,300	134,600		376,900	1,000	108,700		109,700
Sprinkler irrigation system			193,700	193,700			106,500	106,500			87,200	87,200
Wells			77,500	77,500			6,880	6,880			70,620	70,620
Watershed E-1 (Koosharem)												
Koosharem Reservoir enlargement (E1-1)			82,000	82,000			24,500	24,500			57,500	57,500
Wells			170,500	170,500			15,120	15,120			155,380	155,380
Watershed D-8 (Kingston-Junction)												
Canal lining												
Kingston Irrigation Company			39,000	39,000			21,000	21,000			18,000	18,000
Junction Irrigation Company			114,000	114,000			62,500	62,500			51,500	51,500
Wells			77,410	77,410			6,920	6,920			70,490	70,490
Watershed D-1 (Richfield)												
Canal lining			2,210,000	2,210,000			1,200,000	1,200,000			1,010,000	1,010,000
Flat Canyon Debris Basin (D1-1)	853,800			853,800	843,800			843,800	10,000			10,000
Cottonwood Creek Debris Basin (D1-5)	716,500			716,500	706,500			706,500	10,000			10,000
Wells			216,780	216,780			19,430	19,430			197,350	197,350
Watersheds D-2 and 3 (Glenwood)												
Pipelines												
Water Canyon			49,400	49,400			27,300	27,300			22,100	22,100
Sprinkler irrigation system (present lands)			174,800	174,800			96,700	96,700			78,100	78,100
Sprinkler irrigation system (converted lands)			59,800	59,800			33,000	33,000			26,800	26,800
Wells			185,810	185,810			16,650	16,650			169,160	169,160
Watershed A-1 (North Sanpete)												
Canal lining			1,488,580	1,488,580			774,060	774,060			714,520	714,520
Pipelines			1,427,500	1,427,500			742,300	742,300			685,200	685,200
Wells			388,010	388,010			39,550	39,550			348,460	348,460
Stream channel improvement	1,420			1,420	1,320			1,320	100			100
Spring City Fishery		2,920		2,920		1,120		1,120		1,800		1,800
Fairview Lakes Fishery		138,110		138,110		70,680		70,680		67,430		67,430
Waterfowl development		117,580		117,580		31,680		31,680		85,900		85,900
Watershed A-2 (Fountain Green)												
Canal lining												
Fountain Green Irrigation Co.			294,500	294,500			162,750	162,750			131,750	131,750
Wales Reservoir-Silver Creek Irrigation Co.			28,200	28,200			15,500	15,500			12,700	12,700
Pipelines												
Peace Canyon			15,390	15,390			8,490	8,490			6,900	6,900
Reese Canyon			9,570	9,570			5,270	5,270			4,300	4,300
Current Creek			12,370	12,370			6,820	6,820			5,550	5,550
Big Spring			53,250	53,250			29,450	29,450			23,800	23,800
Big Hollow Reservoir (A2-1)	277,620		515,580	793,200	277,550		285,350	562,900	70		230,230	230,300
Distribution canal			16,850	16,850			9,300	9,300			7,550	7,550
Wells			339,510	339,510			34,600	34,600			304,910	304,910
Watershed A-3 (Ephraim)												
Canal lining												
Ephraim Irrigation Co.			924,100	924,100			511,500	511,500			412,600	412,600
Willow Creek Irrigation Co.			200,580	200,580			110,980	110,980			89,600	89,600
Wells			121,250	121,250			12,360	12,360			108,890	108,890
Watershed A-4 (Manti)												
Canal lining												
Manti Irrigation Co.			163,280	163,280			90,330	90,330			72,950	72,950
North Six Mile Irrigation Co.			47,920	47,920			26,470	26,470			21,450	21,450
Manti Irrigation & Reservoir Co.			52,630	52,630			29,080	29,080			23,550	23,550
Wells			363,770	363,770			37,080	37,080			326,690	326,690
Manti Debris Basin (A4-2)	235,400			235,400	235,200			235,200	200			200
Water-based recreation		15,730		15,730		8,680		8,680		7,050		7,050
Watershed C-3 (Gunnison)												
Blue Meadow Reservoir (C3-1)	67,800		271,200	339,000	67,600		150,400	218,000	200		120,800	121,000
Wells (C-1, 2 and 3)			329,230	329,230			29,870	29,870			299,360	299,360
Watershed C-6 (Lost Creek)												
Lost Creek evaporation basin (C6-1)			436,000	436,000			231,000	231,000			205,000	205,000
Watershed C-5 (Salina Creek)												
Bull Pasture Reservoir (C5-4)	118,060	44,270	329,570	491,900	110,140	22,970	170,940	304,050	7,920	21,300	158,630	187,850
Water-based recreation		32,100		32,100		17,800		17,800		14,300		14,300
Skutumpah Reservoir (C5-5)	43,620	14,900	47,880	106,400	34,600	6,570	21,100	62,270	9,020	8,330	26,780	44,130
Water-based recreation		8,800		8,800		4,800		4,800		4,000		4,000
Salina Reservoir (C5-8)	981,510	400,890		1,382,400	795,770	180,560		976,330	185,740	220,330		406,070
Water-based recreation		133,400		133,400		51,900		51,900		81,500		81,500
Wells			89,770	89,770			8,130	8,130			81,640	81,640
Watersheds B-1 and 2 (Levan-Mills)												
Reservoirs	98,400	135,300	176,300	410,000	98,280	75,080	97,820	271,180	120	60,220	78,480	138,820
Canal lining			203,500	203,500			113,000	113,000			90,500	90,500
Pipelines			213,500	213,500			118,550	118,550			94,950	94,950
Wells			593,900	593,900			36,300	36,300			557,600	557,600
Water-based recreation		47,350		47,350		26,300		26,300		21,050		21,050
Watershed B-4 (Scipio)												
Canal lining			523,450	523,450			290,750	290,750			232,700	232,700
Drainage			441,100	441,100			32,900	32,900			408,200	408,200
Reservoir		19,200	874,600	893,800		10,600	483,800	494,400		8,600	390,800	399,400
Water-based recreation		21,200		21,200		11,100		11,100		10,100		10,100
Watersheds B-5, 6 and 7 (Lyndyll-Holden-Delta)												
Central Utah canal lining			889,750	889,750			488,750	488,750			401,000	401,000
Wells			1,665,000	1,665,000			180,000	180,000			1,485,000	1,485,000
GRAND TOTAL	6,118,520	1,705,560	19,605,890	27,429,970	5,755,760	786,110	8,175,330	14,717,200	362,760	919,450	11,430,560	12,712,770

[a]Price base 1967.

its			Average annual cost	Benefit-cost ratio
opment	Local secondary	Total		
80	17,630	155,260	118,580	1.3:1
00	15,020	134,450	89,660	1.5:1
80	22,410	174,270	64,320	2.7:1
20	80	600	90	6.7:1
40	2,010	17,250	8,660	2.0:1
30	40	370	170	2.2:1
90	3,000	23,890	7,040	3.4:1
			23,910	
870	4,490	40,310	24,040	1.6:1
560	560	3,930	2,300	1.7:1
300	320	2,220	970	2.2:1
190	130	1,160	600	1.9:1
250	360	2,400	780	3.1:1
30	19,610	152,480	56,290	2.7:1
90	6,940	66,100	49,650	1.3:1
			10,480	
00	10,470	98,660	75,460	1.3:1
90	2,690	24,600	16,380	1.5:1
10	7,000	54,450	20,100	2.7:1
			8,360	
10	2,930	26,090	14,030	1.8:1
80	1,160	9,880	4,120	2.4:1
30	590	5,580	4,520	1.2:1
20	21,010	163,240	61,850	2.6:1
80	2,700	24,060	14,330	1.7:1
10	330	2,840	1,170	2.4:1
			6,380	
90	1,800	19,240	20,630	0.9:1
60	28,820	231,810	46,430	5.0:1
			4,670	
40	12,000	98,120	24,680	4.0:1
			2,920	
70	8,040	69,320	30,100	2.3:1
40	1,460	12,870	6,630	1.9:1
50	10,680	100,530	87,060	1.2:1
90	5,790	47,350	12,280	3.9:1
			15,060	
50	8,760	73,900	28,490	2.6:1
70	2,970	26,640	16,620	1.6:1
60	3,310	29,440	13,530	2.2:1
40	10,770	87,910	35,050	2.5:1
			9,850	
60	6,740	61,710	42,710	1.4:1
30	11,690	105,350	75,770	1.4:1
60	1,460	11,570	1,470	7.9:1
			12,610	
480	84,000	704,480	203,570	3.5:1
200	10,970	101,320	72,420	1.4:1
			17,140	
00	520,450	4,466,850	2,374,610	1.9:1

TABLE 53--Comparison of structural and groundwater development benefits and costs, Early Action Program, Sevier River Basin, Utah

	Average annual benefits						Average annual costs	Benefit-cost ratio
	Flood prevention	Recreation	AWM[a]	Redevelopment	Local secondary	Total		
Watershed F-5 (Hatch)								
Hatch Reservoir	67,160	26,780	21,090	25,940	17,260	158,230	101,030	1.6:1
Project administration							11,970	
Watershed F-2 (Panguitch Valley)								
Red Canyon debris basin (F2-1)	11,460			4,130	1,720	17,310	18,130	1.0:1
Casto Canyon debris basin (F2-2)	12,020			4,510	1,800	18,330	19,590	0.9:1
Canal lining			59,150	13,750	8,870	81,770	58,620	1.4:1
Wells			20,880	4,580	3,130	28,590	25,600	1.1:1
Project administration							10,250	
Watershed F-3 (Panguitch Creek)								
Panguitch Creek Reservoir (F3-1) and Panguitch Creek channel improvement	6,510	4,700	2,220	2,900	2,010	18,340	12,540	1.5:1
Canal lining			17,080	5,990	2,560	25,630	24,540	1.0:1
Wells			5,000	1,520	750	7,270	6,250	1.2:1
Project administration							3,750	
Watershed F-1 (Circleville)								
Canal lining			47,250	8,250	7,100	62,600	27,440	2.3:1
West Circle Valley canal (F-1 and D-8)			14,120	2,420	2,120	18,660	10,350	1.8:1
Circleville Canyon Reservoir (F1-1)	8,120	13,860	10,430	6,590	4,860	43,860	35,900	1.2:1
Wells			42,000	8,190	6,300	56,490	35,940	1.6:1
Project administration							8,720	
Watershed E-5 (Tropic)								
Canal lining			12,150	2,220	1,820	16,190	9,430	1.7:1
Pipeline	3,220		2,490	250	860	6,820	1,000	6.8:1
Tropic Reservoir enlargement (E5-1)			3,220	460	480	4,160	1,740	2.4:1
Project administration							1,090	
Watershed E-3 (Antimony)								
Antimony Creek Reservoir (E3-2)	7,030	9,480		7,280	2,480	26,270	27,540	0.9:1
Sprinkler irrigation system			36,180	5,220	5,430	46,830	12,260	3.8:1
Wells			35,540	2,550	5,330	43,420	10,460	4.2:1
Project administration							5,460	
Watershed E-1 (Koosharem)								
Koosharem Reservoir enlargement (E1-1)		4,850	3,750	630	1,300	10,530	4,640	2.3:1
Wells			73,710	5,610	11,060	90,380	23,040	3.9:1
Project administration							1,690	
Watershed D-8 (Kingston-Junction)								
Canal lining			16,000	720	2,400	19,120	3,150	6.1:1
Kingston Irrigation Co.			8,870	1,810	1,330	12,010	9,280	1.3:1
Junction Irrigation Co.			28,920	2,560	4,340	35,820	14,320	2.5:1
Wells							1,550	
Project administration								
Watershed D-1 (Richfield)			262,420	41,580	39,360	343,360	179,190	1.9:1
Canal lining								
Flat Canyon debris basin (D1-1a)	33,590		1,860	12,380	5,810	56,910[b]	48,280	1.2:1
Cottonwood Creek debris basin (D1-5)	29,810		710	10,330	5,450	52,100[c]	40,500	1.3:1
Wells			80,760	7,180	12,110	100,050	29,430	3.4:1
Project administration							26,810	
Watersheds D-2 and 3 (Glenwood)								
Water Canyon pipeline		1,000	2,030	790	450	4,270	3,130	1.4:1
Sprinkler irrigation system (Present lands)			7,610	2,800	1,140	11,550	11,070	1.0:1
Sprinkler irrigation system (Converted lands)			4,900	960	740	6,600	3,790	1.7:1
Wells			62,240	6,150	9,340	77,730	25,230	3.1:1
Project administration							5,980	

	Average annual benefits						Average annual cost	Benefit-cost ratio
	Flood prevention	Recreation	AWM[a]	Redevelopment	Local secondary	Total		
Watershed A-1 (North Sanpete)								
Canal lining			117,550	20,080	17,630	155,260	118,580	1.3:1
Pipelines			100,130	19,300	15,020	134,450	89,660	1.5:1
Wells			137,080	14,780	22,410	174,270	64,320	2.7:1
Stream channel improvement	500			20	80	600	90	6.7:1
Fairview Lakes Fishery		13,400		1,840	2,010	17,250	8,660	2.0:1
Spring City Fishery		300		30	40	370	170	2.2:1
Waterfowl development		20,000		890	3,000	23,890	7,040	3.4:1
Project administration							23,910	
Watershed A-2 (Fountain Green)								
Canal lining								
Fountain Green Irrigation Company			29,950	5,870	4,490	40,310	24,040	1.6:1
Wales Reservoir-Silver Creek Irrigation Co.			2,810	560	560	3,930	2,300	1.7:1
Pipelines			1,600	300	320	2,220	970	2.2:1
Peach Canyon			840	190	130	1,160	600	1.9:1
Reese Canyon			1,790	250	360	2,400	780	3.1:1
Current Creek			119,940	12,930	19,610	152,480	56,290	2.7:1
Wells								
Big Hollow Reservoir (A2-1)	15,680	1,320	29,270	12,890	6,940	66,100	49,650	1.3:1
Project administration							10,480	
Watershed A-3 (Ephraim)								
Canal lining			69,790	18,400	10,470	98,660	75,460	1.3:1
Ephraim Irrigation Co.			17,920	3,990	2,690	24,600	16,380	1.5:1
Willow Creek Irrigation Company			42,840	4,610	7,000	54,450	20,100	2.7:1
Wells							8,360	
Project administration								
Watershed A-4 (Manti)								
Canal lining			19,950	3,210	2,930	26,090	14,030	1.8:1
Manti Irrigatinn Co.			7,740	980	1,160	9,880	4,120	2.4:1
Six-Mile Irrigation Co.							4,520	1.2:1
Manti Irrigation and Reservoir Co.			3,960	1,030	590	5,580	61,850	2.6:1
Wells			128,510	13,720	21,010	163,240	14,330	1.7:1
Manti debris basin (A4-2)	17,980			3,380	2,700	24,060	1,170	2.4:1
Campgrounds		2,200		310	330	2,840	6,380	
Project administration								
Watershed C-3 (Gunnison)								
Blue Meadow Reservoir C3-1)	3,000	1,000	8,050	5,390	1,800	19,240	20,630	0.9:1
Wells (C-1, 2 and 3)			192,130	10,860	28,820	231,810	46,430	5.0:1
Project administration							4,670	
Watershed C-6 (Lost Creek)								
Lost Creek evaporation basin (C6-1)			79,980	6,140	12,000	98,120	24,680	4.0:1
Project administration							2,920	
Watershed C-5 (Salina Creek)								
Bull Pasture Reservoir (C5-4)	7,670[d]	9,340	36,600	7,670	8,040	69,320	30,100	2.3:1
Skutumpah Reservoir (C5-5)	2,730[d]	3,830	3,210	1,640	1,460	12,870	6,630	1.9:1
Salina Reservoir (C5-8)	44,380[d]	26,160	660	18,650	10,680	100,530	87,060	1.2:1
Wells			38,570	2,990	5,790	47,350	12,280	3.9:1
Project administration							15,060	
Watersheds B-1 and 2 (Levan-Mills								
Reservoirs	18,130	22,700	17,560	6,750	8,760	73,900	28,490	2.6:1
Canal lining			19,800	3,870	2,970	26,640	16,620	1.6:1
Pipelines			22,070	4,060	3,310	29,440	13,530	2.2:1
Wells			71,800	5,340	10,770	87,910	35,050	2.5:1
Project administration							9,850	
Watershed B-4 (Scipio)								
Canal lining			44,910	10,060	6,740	61,710	42,710	1.4:1
Reservoir and drainage		1,800	77,930	13,930	11,690	105,350	75,770	1.4:1
Campground		9,750		360	1,460	11,570	1,470	7.9:1
Project administration							12,610	
Watersheds B-5 and 7 (Lyndyll-Holden-Oelta)								
Wells			560,000	60,480	84,000	704,480	203,570	3.5:1
Central Utah canal lining			73,150	17,200	10,970	101,320	72,420	1.4:1
Project administration							17,140	
GRAND TOTAL	288,990	172,470	2,960,670	515,200	520,450	4,466,850	2,374,610	1.9:1

[a]Agricultural water management.

[b]Includes $3,270 of indirect benefits.

[c]Includes $5,800 of indirect benefits.

[d]Includes direct flood damage plus sediment damage.

Note: Interest rate at 5-1/8 percent. Costs reflect expected life of 50 or 100 years. Refer to Tables 50 and 51, Summary of reservoir data and Summary of structural measures.

TABLE 54.--Installation schedule, Early Action Program, Sevier River Basin, Utah

Year	Project (Construction start)
1	Wells - Sub-basin A and W.S. B-5, 6 and 7
2	Canal lining - Sub-basin F Wells - W.S. B-1, 2 and Sub-basin C
3	Canal lining - W.S. A-1 and 2 Wells - Sub-basin D and E Big Hollow Reservoir - A2-1
4	Canal lining - W.S. A3, 4 and Sub-basin D Wells - Sub-basin F Manti Reservoir - A4-2
5	Canal lining - W.S. B-1, 2 and 4 Lost Creek evaporation basin - C6-1 Cottonwood Reservoir - D1-5 Flat Canyon Reservoir - D1-1a
6	Bull Pasture Reservoir - C5-4 Skutumpah Reservoir - C5-5
7	Canal lining - W.S. B-4, 5, 6 and 7 Scipio Reservoir - B4-1 Hatch Reservoir - F5-1
8	Reservoirs - B1-1, 2 and 3
9	Salina Reservoir - C5-8
10	Six Mile Creek Reservoir - C3-1 Koosharem Reservoir - E1-1
11	Tropic Reservoir - E5-1 Upper Antimony Creek Reservoir - E3-2 Panguitch Reservoir - F3-1 Canal lining - Sub-basin E
12	Red Canyon Reservoir - F2-1 Casto Canyon Reservoir - F2-2 Circleville Canyon Reservoir - F1-1

TABLE 55.--On-farm land treatment benefits and costs, Early Action Program, Sevier River Basin, Utah

Sub-basin	Total installation costs[a]	Annual costs[b]	Benefits	Benefit cost-ratio
F	660,000	55,570	59,670	1.07:1
E	750,000	61,310	65,610	1.07:1
D	2,415,000	206,150	368,950	1.79:1
A	1,530,000	134,790	200,600	1.48:1
C	2,428,000	206,910	370,500	1.79:1
B	742,000	59,080	277,890	4.72:1
Total	8,525,000[c]	723,810	1,343,220	1.85:1

[a]1965 prices.

[b]Amortization for 100 years at 5 1/8 percent.

[c]Includes $1,491,000 for converted lands.

TABLE 56.--On-farm land treatment measures, Early Action Program, Sevier River Basin, Utah (1965 base)

Sub-basin	Land leveling and sprinkler irrigation systems					Ditch lining and pipelines				
	Presently applied	Total needed[a&b]	To be applied by 1985			Presently applied	Total needed[c]	To be applied by 1985		
			Going program	Accelerated program[b]	Total			Going program	Accelerated program[c]	Total
	Acres	Acres	Acres	Acres	Acres	Miles	Miles	Miles	Miles	Miles
F	3,000	14,700	5,200	2,500	7,700	12	124	35	35	70
E	1,500	11,100	6,800	2,000	8,800	6	116	38	50	88
D	11,000	31,000	7,150	15,000	22,150	24	375	87	105	192
A	6,500	49,000	11,450	11,500	22,950	42	438	243	51	294
C	9,000	33,700	7,650	15,200	22,850	18	422	154	102	256
B	42,000	47,500	46,000	1,000	47,000	23	405	258	57	315
Basin total	73,000	187,000	84,250	47,200	131,450	125	1,890	815	400	1,215

[a]Includes releveling.

[b]Includes 15,000 acres on converted lands.

[c]Includes 190 miles on converted lands.

RANGE IMPROVEMENT AND MANAGEMENT

Development of rangeland resources will facilitate their conservation and will promote economic growth. This section describes the opportunity for increased forage production and management facilities and their benefit-cost evaluation.

Increased forage production will result from removing competing vegetation, seeding, limited fertilization, and improved livestock distribution. Fencing and water developments are necessary to allow proper utilization of forage. In addition to direct livestock and watershed stabilization benefits, this program will also benefit wildlife habitat, aesthetics, reduce erosion, improve on-site productivity and will provide additional employment opportunities.

NATIONAL FOREST DEVELOPMENT OPPORTUNITIES

The extent of range development opportunities by sub-basin is shown in Table 57. The Early Action evaluation alternative includes improved forage production on 225,175 acres, 475 miles of fence, 167 spring water developments and 198 stock watering reservoirs. This range development program will be revised as individual grazing allotment plans are updated and work is completed under going programs. Cost of planned range development is $3,113,750 exclusive of planning costs which are estimated to be $67,600.

Direct benefits include a reduction in erosion of 219 acre-feet annually or about 6 percent of the erosion on U.S. Department of Agriculture administered lands. Annual grazing capacity should increase 45,000 animal unit months with an estimated value of $231,520 annually. Total annual benefits are estimated to be $435,520 (Table 58). Rural and community redevelopment benefits resulting from the Early Action range improvement projects included 88,170 man-days of employment.

PUBLIC DOMAIN DEVELOPMENT OPPORTUNITIES

The extent of range development opportunities by sub-basin is shown on Table 59. This development program includes improved forage production of 140,700 acres, 145 miles of fence, 37 spring water developments, 9 wells and 85 miles of pipeline.

Cost of planned range development is $1,702,800 exclusive of planning costs which are estimated to be $37,000. Direct benefits include a reduction in erosion of 175 acre-feet annually and an increase of livestock and wildlife grazing capacity of 35,300

TABLE 57.--Range improvement opportunities on National Forest lands, Early Action Program, Sevier River Basin, Utah

Treatment	Unit	F	E	D	A	C	B	Total
Existing 1965								
Forage production	Acres	10,060	72,410	14,000	460	5,610	1,470	104,010
Fences	Miles	260	330	200	80	190	140	1,200
Water developments	Each	122	163	96	68	102	39	590
Additional development applied by 1985								
Going programs								
Forage production	Acres	1,190	8,540	1,650	50	660	170	12,260
Fences	Miles	31	39	24	9	22	17	142
Water development	Each	14	19	11	8	12	4	68
Accelerated (Early Action Program)								
Forage production	Acres	28,050	68,340	33,100	31,725	34,870	29,090	225,175
Fences	Miles	77	119	59	70	98	52	475
Water development	Each	46	45	57	40	100	77	365

TABLE 58.--Comparison of benefits and costs, range improvement opportunities on National Forest lands, Early Action Program, Sevier River Basin

	F	E	D	A	C	B	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
ANNUAL BENEFITS							
Erosion reduction benefits @$500 per acre-foot	8,000	28,500	22,000	13,500	21,500	15,500	109,000
Grazing benefits @$5.00 per AUM	28,050	68,340	33,100	31,720	34,870	29,090	225,170
Employment and redevelopment benefits	6,800	14,310	7,430	7,190	9,070	6,890	51,690
Secondary benefits	5,360	14,390	8,180	6,740	8,380	6,610	49,660
Total annual benefits	48,210	125,540	70,710	59,510	73,820	58,090	435,520
Total installation costs	409,700	862,200	447,400	433,250	546,300	414,900	3,113,750
ANNUAL COSTS							
Amortization of installation costs (100 yrs. @5 1/8%)	21,140	44,490	23,080	22,360	28,190	21,410	160,670
Replacement operation and maintenance	9,320	19,620	10,180	9,860	12,430	9,440	70,850
Total annual cost	30,460	64,110	33,260	32,220	40,620	30,850	231,520
Benefit-cost ratio	1.6:1	1.9:1	2.1:1	1.8:1	1.8:1	1.9:1	1.9:1

TABLE 59.--Range improvement opportunities on Public Domain lands, Early Action Program, Sevier River Basin

Treatment	Unit	F	E	D	A	C	B	Total
Early Action Program								
Forage production	Acres	33,400	26,000	9,800	5,000	9,000	57,500	136,200
Fences	Miles	27	20	15	10	10	63	145
Water developments	Each	10	8	10	2		16	46
Pipelines	Miles	40	15	30				85

AUMs. Benefits of retaining soil on-site are about $87,500 annually. Redevelopment benefits are about $28,260 and secondary benefits about $39,210 annually. Total annual benefits are estimated at $331,530 and total annual costs at $126,600 resulting in a benefit-cost ratio of 2.6 to 1 (Table 60).

PRIVATE DEVELOPMENT OPPORTUNITIES

The accelerated range development program on private land is shown in Table 61. Treatment measures include brush control on 21,700 acres, seeding on 7,950 acres, 59 spring water developments, and 86 miles of fence.

Benefits and costs are shown in Table 62. The total cost of the accelerated range development program would be $446,900 including $229,820 of Federal funds. Direct benefits include a reduction in erosion of 37 acre-feet of sediment annually and an increase in livestock grazing capacity of 5,700 AUMs with annual values of about $18,000 and $32,730, respectively. Redevelopment benefits are about $7,420 and secondary benefits $7,570 annually. Estimated total annual benefits are $65,720 and total annual costs $33,220 resulting in a benefit-cost ratio of 2.0:1.

INTERRELATIONSHIPS

Forage improvement on 391,000 acres suitable for intensive livestock management will permit steep hillsides and other less suitable areas presently grazed to rest and facilitate their recovery. For this reason, this program is closely related to the watershed stabilization program.

Reduced erosion rates will also result in less sediment damage downstream. Although range development was not considered on critical areas, this program will also have downstream impacts.

Many livestock graze different parts of the year on different ownerships of land. This is true especially in the case of sheep which winter on Public Domain lands, graze spring and fall on private lands and summer on National Forest lands. Because of these grazing patterns, range improvement programs should be coordinated by ownership and period of use.

Domestic livestock grazing should be coordinated with recreation, mining, wildlife, reforestation, and some occupancy uses. The interrelationship of all uses on the land should be carefully harmonized to maintain environmental quality.

TABLE 60.--Comparison of benefits and costs, range improvement opportunities on Public Domain lands, Early Action Program, Sevier River Basin

	F	E	D	A	C	B	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
ANNUAL BENEFITS							
Erosion reduction benefits @$500 per acre-foot	21,000	16,000	6,000	3,000	5,500	36,000	87,500
Grazing benefits @$5.00 per AUM	45,380	21,250	10,000	3,850	6,930	89,150	176,560
Employment and redevelopment benefits	6,880	5,070	2,560	1,050	1,690	11,010	28,260
Secondary benefits	9,830	5,540	2,390	1,030	1,850	18,570	39,210
Total annual benefits	83,090	47,860	20,950	8,930	15,970	154,730	331,530
Total installation cost	414,400	305,400	154,000	63,600	102,000	663,400	1,702,800
ANNUAL COSTS							
Amortization of installation cost (100 yrs. @ 5-1/8%)	21,380	15,760	7,950	3,280	5,260	34,230	87,860
Replacement operation and maintenance	9,430	6,950	3,500	1,450	2,320	15,090	38,740
Total annual cost	30,810	22,710	11,450	4,730	7,580	49,320	126,600
Benefit-cost ratio	2.7:1	2.1:1	1.8:1	1.9:1	2.1:1	3.1:1	2.6:1

TABLE 61.--Range improvement opportunities on private lands, Early Action Program, Sevier River Basin

Treatment	Unit	F	E	D	A	C	B	Total
Existing 1965								
Forage production	Acres	7,280	8,800	4,510	26,930	19,570	17,330	84,420
Fences	Mile	48	51	80	169	121	323	792
Water development	Each	23	53	81	263	215	112	747
Additional development applied by 1985								
Going programs								
Forage production	Acres	4,260	4,820	2,760	16,120	10,820	21,800	60,580
Fences	Mile	6	6	9	20	14	38	93
Water developments	Each	40	40	40	140	120	80	460
Early Action Program								
Forage production	Acres	2,440	5,340	4,280	5,610	2,840	9,140	29,650
Fences	Mile	5	6	9	18	13	35	86
Water developments	Each	4	5	5	15	15	15	59

TABLE 62.--Comparison of benefits and costs, range improvement opportunities on private lands, Early Action Program, Sevier River Basin

	F	E	D	A	C	B	Total
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
ANNUAL BENEFITS							
Erosion reduction benefits @$5.00 per acre-foot	1,500	3,500	2,500	3,500	1,500	5,500	18,000
Grazing benefits @$5.00 per AUM	3,320	4,370	4,370	4,320	2,180	14,170	32,730
Secondary benefits	720	1,130	1,040	1,150	580	2,950	7,570
Employment and redevelopment benefits	560	1,070	960	1,490	930	2,410	7,420
Total annual benefits	6,100	10,070	8,870	10,460	5,190	25,030	65,720
Total installation cost	33,600	64,600	57,600	89,700	56,000	145,400	446,900
ANNUAL COSTS							
Amortization of installation cost (100 yrs. @ 5-1/8%)	1,730	3,330	2,970	4.630	2,890	7,500	23,050
Replacement operation and maintenance	760	1,470	1,310	2,040	1,270	3,310	10,160
Total annual cost	2,490	4,800	4,280	6,670	4,160	10,810	33,210
Benefit-cost ratio	2.4:1	2.1:1	2.1:1	1.6:1	1.2:1	2.3:1	2.0:1

ALTERNATIVES

Broad alternatives are discussed in Chapter IV. Alternative levels of development between sub-basins and between programs are implicit in the data and have an infinite range. Development of on-farm pastures could be an alternative to increased rangeland production. Economic objectives of this program could be met by shifting emphasis to recreation or other development.

RECREATION DEVELOPMENT

The proximity of the Sevier River Basin to National Parks and Monuments, outstanding scenic vistas, and highways I-15 and I-70 combine to create opportunities for recreation development and enhancement. Perhaps the greatest opportunity to stimulate the economy is related to outdoor recreation, tourism, and housing for recreation and retirement. Recent increases in recreational development, real estate values, and absentee property owners from population centers such as southern Nevada and California are indicative of recent trends. By 1985, basin-wide outdoor recreation use is expected to reach 4,695,000 visitor-days annually as compared to 1,705,000 visitor-days use in 1965. This section describes needed related land recreation development.

Wide variations in the cost of recreation development make a meaningful evaluation difficult. An example in the National Forests is campground development. These facilities are planned to range from the very primitive to provide maximum contact with nature to more elaborate areas which tend to isolate the user from a natural experience. On National Forests, 24 percent of existing recreation use occurs on roads and on Public Domain lands, 39 percent. Because roads are constructed to serve other multiple uses as well as recreation this further complicates a meaningful evaluation. Fishing and boating are definitely within the realm of water related resource development as described in the Early Action Program but the applicability of other development is not as certain.

NATIONAL FOREST RECREATION DEVELOPMENT

Recreation demand is expected to increase from 752,000 visitor-days in 1965 to 2,066,000 visitor-days by 1985. Developments needed are related to water--fishing and boating--and land developments including campgrounds, picnic sites, resorts, organization sites, recreation residences, roads, trails, observation sites and winter sports sites. Related land development was restricted to campground and picnic site development (Table 63).

TABLE 63.--Comparison of recreation development benefits and costs, National Forest lands, Early Action Program, Sevier River Basin

	Unit	Amount
Annual Benefits		
Visitor-days recreation use	Visitor-day	315,360
Annual benefit @$1.50 per visitor-day	Dollar	473,040
Redevelopment benefits	Dollar	24,040
Secondary benefits	Dollar	70,960
Total annual benefits	Dollar	568,040
Annual Costs		
Development units planned[a]	Number	2,222
Total cost @$2,200 per unit	Dollar	4,888,400
Amortization of development costs 100 years @5 1/8 percent	Dollar	252,240
Operation, maintenance and replacement @$50/unit annually	Dollar	111,100
Total annual costs	Dollar	363,340
Benefit-cost ratio		1.6:1

[a]Planned development unit is a campground family unit consisting of parking space, table, grill, water and sanitation representing an average in cost similar to other types of recreation development.

Direct recreation benefits, redevelopment benefits and secondary benefits are $568,040 annually. Project annual costs are estimated to be $363,340. This evaluation was based on 2,222 family campground and picnic units that could provide 315,360 visitor-days recreation use. Installation cost of evaluated development is $4,888,400 exclusive of $106,000 of planning costs.

PUBLIC DOMAIN RECREATION DEVELOPMENT

Recreation demand is expected to increase from 85,000 visitor-days in 1965 to 235,000 visitor-days in 1985. Installation costs for the 125 family campground units needed is $275,000 exclusive of planning costs which are estimated at $6,000. Using similar costs and benefits as on National Forest lands, the economic evaluation will show the same feasibility, therefore, it is not repeated.

RECREATION DEVELOPMENT ON PRIVATE LAND

Recreation is growing on private lands also. Recreational ranching is providing opportunities for people to enjoy themselves while participating in rural life. There is opportunity to expand this type of program. Recreation opportunities on private lands include campgrounds, vacation farms, roads, riding stables, resorts, hunting preserves and recreation residences. Related land recreation development on private lands was not evaluated. Recreation demand is expected to increase from 68,000 visitor-days annually on private lands in 1965 to 188,000 visitor-days annually by 1985.

INTERRELATIONSHIPS

Water creates the focal point for most recreational development. Small streams with their riparian vegetation are favored for recreational development sites at lower elevations. At higher elevations, although abundant shade is found away from water courses, the aesthetic attraction of water or fishing opportunities still is a primary focal point for campground and picnic site development. Recreation development requires water of potable quality and proper sanitary facilities to maintain water quality downstream. Recreation development must be enhanced by a pleasing environment for the visitor.

SCHEMATIC DRAWING

The schematic drawing (Figure 1) shows the relative position of the major drainages of the Sevier River system along with the sub-basins and watersheds. This is presented to show the relative location of the development opportunities and provide an overall view of their interrelationships.

The tabular summaries indicate the total development by sub-basin. The hydrologic impacts are shown as they effect the water supply, use and outflow for present conditions and Early Action Program developments. Changes in the level of development would be reflected in changes of the hydrologic situation. Also, the impacts of the probable importation of water through the Central Utah Project are not included in the values given.

D-283

D-1

DI-5(F.S.)

River

Venice - Glenwood

DI-1a (F.S.)

Richfield

Sub-Basin D
RESOURCE DEVELOPMENT

Range Improvement	9,500 AUM
Sediment Reduction	22 Ac.Ft.
Flood Prevention	3,500 Ac.Ft.
Irrigation Water	
Reservoir Storage	
Groundwater Monagement	80,000 Ac.Ft.
Salvage	16,490 Ac.Ft.
Canal Lining (Including Pipelines)	95 Miles

	Present	Early Action
Water Available	286,610 Ac.Ft.	285,590 Ac.Ft.
Water Used	156,610 Ac.Ft.	159,350 Ac.Ft.
Outflow	130,000 Ac.Ft.	126,240 Ac.Ft.

D-4 Manroe - Annobella

Sevier

D-5 Cleor Creek

D-7

Marysvale

D-6 Manning Creek

D-8 Junction

D

E

F

Sub-Basin E
RESOURCE DEVELOPMENT

Range Improvement	18,800 AUM.
Sediment Reduction	36 Ac.Ft.
Flood Prevention	920 Ac.Ft.
Irrigation Water	
Reservoir Storage	800 Ac.Ft.
Groundwater Management	15,000 Ac.Ft.
Salvage	7,280 Ac.Ft.
Canal Lining (Including Pipelines)	4 Miles

	Present	Early Action
Water Available	104,410 Ac.Ft.	104,080 Ac.Ft.
Water Used	53,080 Ac.Ft.	52,400 Ac.Ft.
Outflow	51,330 Ac.Ft.	51,680 Ac.Ft.

EI-1 (I.R.)

E-1 Kooshorem

Creek

E-2 Greenwich - Anglo

Otter

E-3

River

E3-2 (F.R.)

Antimony

Sevier

John's

E-4

Valley

Fork

East

E-5 Tropic

E5-1 (I.S.)

F-1 Circleville

River

F-2 Panguitch Valley

Sub-Basin F
RESOURCE DEVELOPMENT

Range Improvement	15,300 AUM.
Sediment Reduction	58 Ac.Ft.
Flood Prevention	18,335 Ac.Ft.
Irrigation Water	
Reservoir Storage	3,675 Ac.Ft.
Groundwater Management	78,000 Ac.Ft.
Salvage	4,810 Ac.Ft.
Canal Lining (Including Pipelines)	2 Miles

	Present	Early Action
Water Available	144,100 Ac.Ft.	144,100 Ac.Ft.
Water Used	55,670 Ac.Ft.	57,050 Ac.Ft.
Outflow	88,430 Ac.Ft.	87,050 Ac.Ft.

F-3

F3-1 (I.F.S.R.)

F2-2 (F.S.)

Panguitch

F2-1 (F.S.)

Sevier

F-4 Hillsdale

F-5 Hatch

F5-1 (I.F.S.R.)

LEGEND

- A/B — Sub-Basin Boundary
- Watershed Boundary
- F-5 Hatch — Watershed Number and Nome
- On Farm Development
- Lining
- Sediment Reduction
- Well Development
- Recreation Development
- Range Improvement
- Fishery Development
- Waterfowl Development
- Reservoir
- E5-1 — Reservoir Number
- (I.F.S.R.) — Reservoir Purpose
  - Irrigation
  - Flood
  - Sediment
  - Recreation

N

FIGURE 1
SOUTH HALF
EARLY ACTION PROGRAM
RESOURCE DEVELOPMENT
SEVIER RIVER BASIN
UTAH
AUGUST 1970

River

B-3

Tintic Wash

B-5,6&7

Lynndyl-Holden-Delta

B-4 Scipio

B-1 & 2 Levan

B1-2 (I.F.S.R.)

B1-3 (I.F.S.R.)

B1-1 (I.F.S.R.)

B/C

C-1 Fayette

C-2 Redmond

C-3 Gunnison

C-4 Willow Creek

C-5 Salina Creek

C5-5 (I.F.S.R.)

C5-4 (I.F.S.R.)

C5-8 (I.F.S.R.)

C-6 Lost Creek

C6-1 (Pollution Control)

A2-1 (I.F.S.R.)

A-2 Fountain Green

A-1 North Sanpete

A-3 Ephraim

A-4 (I.F.S.R.)

C3-1 (I.R.)

A/C

San Pitch

River

Sevier

Sevier

BASIN BOUNDARY

To Sevier Lake (Intermittent)

N

Sub-Basin B
RESOURCE DEVELOPMENT

Range Improvement	26,500 A.U.M.
Sediment Reduction	23 Ac.Ft.
Flood Prevention	695 Ac.Ft.
Irrigation Water	
Reservoir Storage	6,270 Ac.Ft.
Groundwater Management	82,000 Ac.Ft.
Salvage	27,570 Ac.Ft.
Canal Lining (Including Pipelines)	78 Miles

	Present	Early Action
Water Available	413,460 Ac.Ft.	420,350 Ac.Ft.
Water Used	394,610 Ac.Ft.	387,100 Ac.Ft.
Outflow	18,850 Ac.Ft.	33,250 Ac.Ft.

Sub-Basin A
RESOURCE DEVELOPMENT

Range Improvement	8,000 A.U.M.
Sediment Reduction	12 Ac.Ft.
Flood Prevention	1,085 Ac.Ft.
Irrigation Water	
Reservoir Storage	1,425 Ac.Ft.
Groundwater Management	300,000 Ac.Ft.
Salvage	26,860 Ac.Ft.
Canal Lining (Including Pipelines)	203 Miles

	Present	Early Action
Water Available	260,560 Ac.Ft.	260,910 Ac.Ft.
Water Used	236,700 Ac.Ft.	225,040 Ac.Ft.
Outflow	23,860 Ac.Ft.	35,870 Ac.Ft.

Sub-Basin C
RESOURCE DEVELOPMENT

Range Improvement	8,800 A.U.M.
Sediment Reduction	47 Ac.Ft.
Flood Prevention	13,950 Ac.Ft.
Irrigation Water	
Reservoir Storage	5,380 Ac.Ft.
Groundwater Management	65,000 Ac.Ft.
Salvage	21,100 Ac.Ft.
Canal Lining (Including Pipelines)	—

	Present	Early Action
Water Available	326,240 Ac.Ft.	334,490 Ac.Ft.
Water Used	185,860 Ac.Ft.	187,220 Ac.Ft.
Outflow	140,380 Ac.Ft.	147,270 Ac.Ft.

LEGEND

- A/B — Sub-Basin Boundary
- Watershed Boundary
- F-5 Hotch — Watershed Number and Name
- On Farm Development
- Lining
- Sediment Reduction
- Well Development
- Recreation Development
- Range Improvement
- Fishery Development
- Waterfowl Development
- Reservoir
- A3-5 — Reservoir Number
- (I.F.S.R.) — Reservoir Purpose
  - Irrigation
  - Flood
  - Sediment
  - Recreation

FIGURE 1
NORTH HALF
EARLY ACTION PROGRAM
RESOURCE DEVELOPMENT
SEVIER RIVER BASIN
UTAH
AUGUST 1970

DEVELOPMENT IMPACTS

ECONOMIC IMPACTS

The proposed Early Action Program should produce annual benefits of $8,238,330 with annual costs of $4,257,100. This will result in an annual surplus of $3,981,230. Total investment required would be $56.1 million. A summary of annual costs and benefits is shown in Table 64. Installation of the Early Action Program will increase per capita income by $244. This would reduce the projected 1980 per capita income deficit of $1,244 to $1,000 when compared to the United States. An additional $5.2 million in agricultural products will be produced annually along with increased demand for farm inputs.

In addition to increased agriculturally related income, the following benefits would result from the program:

1. An additional 3,085 man-years of employment and $20.8 labor income will result from construction of the project.

2. An additional $20.9 million of goods and service will be purchased within the Basin during the construction phase.

3. Beneficial effects of enlarged tax base and community stability.

4. About 603,000 visitor-days annually of recreation use will increase income and employment to individuals and firms providing goods and services.

HYDROLOGIC IMPACTS

The Sevier River Basin is composed of many interrelated diverse areas, each with its own hydrologic characteristics. Water development within any area will have a direct impact downstream. These hydrologic characteristics also require the conjunctive management of the surface water and groundwater. The hydrologic impacts, sub-basin by sub-basin have been described earlier in this chapter.

The Early Action Program alternative evaluated would eliminate 74,870 acre-feet of the present average root-zone water shortage on irrigated lands. Consumptive use of moisture in the wet areas would be reduced by 95,320 acre-feet and increased by 86,270 acre-feet in the irrigated cropland areas. In the process,

TABLE 64.--Total cost and annual cost and benefits from installation of proposed Early Action Program, Sevier River Basin

Item	Installation cost[a]	Annual cost[b]	Annual benefit	Annual net benefits
	Dollars	Dollars	Dollars	Dollars
Agricultural water management				
Pipelines	2,225,060	136,790	244,740	107,950
Canal lining	9,212,600	737,860	1,227,450	489,590
Reservoirs	3,165,290	178,270	289,810	111,540
Wells and land conversion	5,002,940	670,160	2,055,740	1,385,580
On-farm practices	8,525,000	723,810	1,343,220	619,410
Sub-total	28,130,890	2,446,890	5,160,960	2,714,070
Flood control				
Debris basins	2,425,700	140,830	168,280	27,450
Reservoirs and channel improvements	3,692,820	207,180	258,860	51,680
Sub-total	6,118,520	348,010	427,140	79,130
Recreation				
Project related	1,705,560	114,870	221,970	107,100
National Forest land	4,888,400	363,340	568,040	204,700
Public land	275,000	20,350	31,810	11,460
Sub-total	6,868,960	498,560	821,820	323,260
Erosion control				
National Forest land	8,018,400	468,000	793,500	325,500
Public land	1,473,200	90,700	161,700	71,000
Private land	220,200	13,610	40,440	26,830
Sub-total	9,711,800	572,310	995,640	423,330
Range improvements				
National Forest land	3,113,750	231,520	435,520	204,000
Public land	1,702,800	126,600	331,530	204,930
Private land	446,900	33,210	65,720	32,510
Sub-total	5,263,450	391,330	832,770	441,440
Grand total	56,093,620	4,257,100	8,238,330	3,981,230

[a]Based on 1965 prices.

[b]Amortized at 5 1/8 percent.

29,680 acres of irrigated nonrotated cropland and wetlands would be converted to irrigated rotated cropland. Total surface water diversions to irrigated areas will be reduced by 2,690 acre-feet and well diversions would be increased by 108,885 acre-feet. Net water surface evaporation will decrease 740 acre-feet.

The regimen of stream and river flows will be altered considerably in some areas. In many reaches, month to month flows will be stabilized significantly compared to the present situation. In other areas, total annual volume of flows will be increased or decreased.

Because of these interrelationships, basin-wide coordination of developments is necessary if detrimental downstream impacts on river and stream flows is kept at a minimum. Some individual developments will stand alone, others will not. A few have no impact outside the immediate watershed area while others effect the entire river system.

LAND RESOURCE AND ENVIRONMENTAL IMPACTS

The National Environmental Policy Act of 1969 declares a National policy which will encourage productive and enjoyable harmony between man and his environment. This law specifically requires:

> "Include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on:
>
> a. The environmental impact of the proposed action.
>
> b. Any adverse environmental effects which cannot be avoided should the proposal be implemented."

This section describes the impact of Early Action development on environmental quality and other resources to the extent possible at the level of investigation evaluated.

Watershed Stabilization and Improvement

The Early Action Program evaluated could have an impact on 357,830 acres. This includes 59,900 acres of contour trenching or furrowing and 297,930 acres of vegetation improvement. Also included are 597 miles of stream channel stabilization on perennial streams along with other stream channel and soil stabilization work.

Adjustment in livestock grazing will be required as the stabilization program is installed. Later, increased productivity will increase the carrying capacity by 3,108 animal unit months annually as a result of this program.

Environmental enhancement will result by removing sediment from streams and restoring the productivity of the land. Improved aesthetics and fish and wildlife habitat also result.

Possible adverse environmental impacts may result from vegetation removal and disposal. Large blocks of pinyon-juniper removal and replacement by grass cover may not be aesthetically desirable. Loss of the area to the production of wood and tree products and the feasibility of some pinyon areas for quality Christmas tree production should be considered in future evaluation of areas to be converted. Adverse aesthetic impacts can be mitigated through irregular layout of treatment areas, breaking up large blocks of treatment with small patches of pinyon-juniper and reducing the visibility of treated areas in relation to road locations.

Burning of windrows can adversely effect air quality, however, leaving large unburned windrows of dead brush is also aesthetically undesirable. Adequate wildlife cover should be left to prevent adverse impacts to animal and bird life. Relationships of sage grouse to sagebrush are extremely critical and nesting areas, strutting grounds and other areas essential to these birds should not be treated.

Soil disturbing activities such as contour trenching and furrowing, and stream stabilization measures should be hidden from view, existing vegetation left undisturbed as far as possible, and structures installed that will blend with natural features of the streams and landscape. Additional studies of biotic interrelationships are essential to assure coordination of development with all aspects of the biosphere.

Water Resource Development, Improvement and Management

This section describes resource and environmental impacts in three parts; reservoirs and debris basins, groundwater management, and other developments.

Reservoirs and Debris Basins Reservoirs and debris basins include nine multiple-purpose reservoirs, enlargement of two existing multiple-purpose reservoirs, nine debris basins and one evaporation basin. Environmental improvement resulting from these developments will generally enhance the aesthetic quality of the area and particularly that of the water resource.

Well planned impoundment structures have a special attraction and are always popular where recreation use is possible. Stabilized streamflows will provide perennial fish habitat through many presently intermittent reaches of the river system. Riparian areas can be maintained in their natural state without periodic damage from flood flows and sediment deposition. Improved water quality through reduced sediment loads and other forms of pollution can increase the utilization of this resource for many avenues of recreation, wildlife and crop production. Damaging and unsightly scars left in the natural environment can be repaired and prevented in the future.

Possible adverse impacts related to storage reservoirs include exposure of bare soil, mud flats formed by deposition of sediments, and bank erosion as water levels are lowered. These areas may also produce an unpleasant odor which detracts from a desirable environment. Adverse aesthetic impacts can be mitigated by reducing disturbance to existing vegetation, reducing undesirable visibility from roads by their location, using screening, reducing heavy drawdown during the recreation seasons and revegetating borrow and construction areas. Fish habitat, riparian vegetation, and stream stability below reservoirs can be damaged through complete diversion or release of large flows of water, especially if such releases flush accumulated silt downstream.

Groundwater Management Management and development of groundwater could have a major impact on the water and land resources along with the total environment. Table 65 indicates the land area effected.

The water table would be lowered on 38 percent of the wetland areas and 77 percent of the irrigated nonrotated cropland areas in those watersheds where water salvage is evaluated. About 6 percent of the wetland areas and all of the irrigated nonrotated areas affected could be converted to fully irrigated rotated cropland. This would permit more productive use of the land and result in increased operator income. Large areas of sparsely vegetated saltgrass-brush pastures would be eliminated creating a more attractive surrounding. Small, stagnant water surfaces would be reduced in size or eliminated along with insect breeding areas.

The specific effects of lowering water tables on these lands is not completely known. Wetland areas support plant, fish, insect, animal and bird life; all closely related to water levels. Lowering water tables will affect this biotic community with its complex interrelationships. Studies on the environmental and resource impact are needed prior to initiating basin-wide development. Also, effects on the quality of groundwater aquifers should be investigated in more detail.

TABLE 65.--Impact on land use through water salvage, Early Action Program, Sevier River Basin, Utah

Hydrologic unit	Wetlands and phreatophytes					Irrigated nonrotated cropland		
	Existing	Converted to rotated cropland		Other affected areas		Existing	Converted to rotated cropland	
	Acres	Acres	Percent	Acres	Percent	Acres	Acres	Percent
F-1	1,670	680	40	170	10	1,680	1,000	60
F-2	2,170	1,000	46	470	22	740	300	25
F-3	670	-	-	-	-	480	200	42
Sub-basin F	5,340	1,680	31	640	12	3,990	1,500	37
E-1	3,040	500	16	2,540	84	2,840	2,400	84
E-3	1,070	300	28	750	70	1,190	800	67
E-4	340	-	-	-	-	550	300	54
Sub-basin E	5,120	800	16	3,290	64	4,840	3,500	72
D-1	1,410	800	57	250	18	3,340	3,200	96
D-2 and 3	4,480	1,500	33	2,980	66	690	500	72
D-4	1,530	200	13	400	26	380	300	79
D-6	460	-	-	-	-	640	400	62
D-7	1,640	-	-	-	-	690	600	87
D-8	770	-	-	580	75	300	200	67
Sub-basin D	10,480	2,500	24	4,210	40	6,040	5,200	86
A-1	15,390	1,600	10	7,840	51	-	-	-
A-2	12,040	1,400	12	6,940	58	-	-	-
A-3	4,100	500	12	210	5	-	-	-
A-4	13,050	1,500	11	8,390	64	-	-	-
Sub-basin A	44,580	5,000	11	23,380	52	-	-	-
C-1	4,670	800	17	3,690	79	2,650	2,500	94
C-2	4,340	600	14	2,230	51	2,610	2,500	96
C-3	1,850	300	16	1,330	72	1,400	1,200	86
C-4	410	50	12	-	-	60	-	-
C-5	1,070	200	19	540	50	1,440	1,300	90
C-6	300	50	17	100	33	50	-	-
Sub-basin C	12,660	2,000	16	8,790	69	8,210	7,500	91
B-1 and 2	3,400	-	-	1,180	35	-	-	-
B-4	1,900	-	-	510	27	-	-	-
B-6	7,770	-	-	980	13	-	-	-
B-7	118,370	-	-	24,990	21	-	-	-
Sub-basin B	131,440	-	-	27,660	21	-	-	-
Basin	209,620	11,980	6	67,970	32	23,080	17,700	77

CENTRAL UTAH WATER IMPORTATION

The water users have long looked to importation of water from outside sources to provide a more firm water supply. One of the sources is the Bonneville Unit of the Central Utah Project which is planned and being constructed by the Bureau of Reclamation. The Bonneville Unit includes local developments in the Uinta and Bonneville Basins and the diversion of water from the Uinta Basin for multiple purpose usage in the Bonneville Basin. The complex project costing more than $324 million, includes seven new reservoirs and the enlargement of two existing reservoirs; more than 140 miles of aqueducts, tunnels, and canals; three powerplants and several pumping plants.

The Sevier River water users, Utah State Board of Water Resources, and Central Utah Water Conservancy District requested the Bureau to study the possibilities of importation of water to the Sevier River Basin. The Bureau of Reclamation has subsequently planned a modification of the Bonneville Unit which would provide 36,000 acre-feet of water annually, measured at Strawberry Reservoir, for supplemental irrigation in the Sevier River Basin. This would enable about 13,000 acre-feet annually to be diverted by canals in the Central-Sevier Area (between Piute and Sevier Bridge Reservoirs) and about 15,000 acre-feet annually to be diverted by canals in the Lower Sevier area (below Sevier Bridge Reservoir).

The water exchange to lands above Sevier Bridge Reservoir is planned only for the areas downstream from Piute Reservoir because of the limited supply available for exchange and because existing facilities in these areas are adequate for storage and distribution. Some additional facilities would be required to effect an exchange in the upper area above Piute Reservoir.

Other Developments Canal lining, pipelines and other resource developments will generally present a pleasing scene of proper husbandry of the water and land resources and have a favorable effect on environmental quality. Enclosing natural streams in a pipeline or lined canal, however, could create environmental problems by removing water needed to sustain riparian vegetation, destroying fish habitat and making water unavailable for other wildlife and domestic livestock.

Range Improvement and Management

Forage improvement was evaluated on 395,525 acres; also 706 miles of fence and 470 water developments were considered. Cattle and sheep could be removed from lands which are unsuitable for livestock grazing and placed on lands or a more gentle topography at lower elevations and with longer growing seasons. Resource protection will result through decreased erosion rates and improved forage for wildlife on key game ranges.

Adverse environmental impacts could result from large blocks of pinyon-juniper or sagebrush removal with subsequent aesthetic and biotic effects. Fencing helps destroy the image of unrestricted open space, a prime asset on desert lands. Water developments are frequently serviced by sub-standard roads. Adverse effects can be mitigated by quality construction standards and by blending developments with the natural landscape.

Outdoor Recreation Development

Planned recreation includes campground and water surface development to meet needs by 1985. This includes 814 acres of water surfaces and 2,383 campground family units.

People enjoy recreational pursuits in direct relation to the environmental quality. Maintaining pleasing scenic vistas of cultural harmony between communities and cultivated land, pastoral scenes of pasture and rangeland, and verdant mountains providing a background to this peaceful scene is an important recreational resource. These qualities will be enhanced through the Early Action Program.

Recreational development also has adverse environmental impacts. Roads built for access, indiscriminate sub-division of recreation residence development, lack of sanitation and management facilities, litter and destruction of wildlife and other resources can destroy the very qualities that now attract recreationists. Adverse impacts can be minimized through proper planning and development of facilities and by developing a sense of social responsibility among recreation users.

CHAPTER IV

ALTERNATIVES AND LONG-RANGE DEVELOPMENT

This chapter establishes development needs. Also, opportunities that exist to satisfy needs and alternative combinations of opportunities are described providing a basis for decision making between alternatives.

FUTURE NEEDS

This section describes the long-term water and related land development needs. These are presented in terms of the total need on a basin-wide basis.

ECONOMIC

Additional employment is needed to encourage young people to stay in the area and reduce unemployment and underemployment. When compared to other areas, the Basin has larger families, lower earnings per worker and worker participation ratio which results in lower per capita income. With development, income levels should be improved relative to other areas.

AGRICULTURE

Projections show increased needs by 1980, 2000 and 2020 for all products grown in the area. Within the framework of technological changes expected in agriculture, the increased needs for agricultural products can be provided without developing additional irrigated land. However, development to provide a full water supply to presently irrigated lands is needed.

WATER

Development of the existing water resource is needed to alleviate present irrigation water shortages. Improvement is also needed in control of peak flows, timing, distribution and quality.

Management and Distribution

A total long-term storage capacity, both surface and groundwater, of between 750,000 and 1,000,000 acre-feet is needed to stabilize average irrigation water supplies during the historical 15-year dry cycle. The need for seasonal regulatory storage is greatest on unregulated tributary streams and the upper reaches of the Sevier River main stem. Regulatory storage needs, either surface or groundwater, in these areas is estimated at an additional 18,000 acre-feet.

About 70 percent of the main canals have a seepage loss greater than 3 percent per mile and 25 percent have a loss greater than 6 percent per mile. About 1,000 miles of canal lining or consolidation are needed. Solutions to upper watershed damage caused by transmountain diversions are also needed.

There is a need to improve on-farm irrigation efficiencies to make better use of the water resource, increase yields and use the land to its full potential. An increased irrigation efficiency of 10 percent is needed to reduce the magnitude of other development measures.

Improved Quality

Structural and watershed stabilization measures are needed to control sediment yield from critical areas of over 860 acre-feet annually. Concentrations of dissolved solids need to be reduced from the present 2,000-3,000 milligrams per liter to 1,000-2,000 milligrams per liter in the lower Sevier River. Bacterial and chemical pollution safeguards are needed to assure that minimum health standards of Class "C" waters as defined by the State of Utah are not exceeded.

Flood Control

Drainages within 23 of the watersheds need structural measures to control floodwaters. Flood control storage of about 15,400 acre-feet and watershed stabilization is needed to alleviate damages to downstream developments.

Flood channels on tributary drainages are needed in 4 watersheds to bypass flows that cannot be controlled with other measures. In addition, sections of the Sevier River main stem and large tributaries in 6 watersheds need enlarged capacities to handle peak snowmelt floods.

RELATED LAND

Land resources have deteriorated in many areas. Protection and improvement of the productivity of the land are needed to maintain these resources and to improve the aesthetic quality of the environment.

Watershed Stabilization

The need for watershed stabilization is indicated by (1) Erosion is heavy to excessive on 20 percent of the land evaluated, (2) forty-four percent of the stream channels are in poor condition on National Forest lands, and (3) critical areas are eroding annually at a rate of 4,250 acre-feet on 1,119,300 acres of land. Watershed stabilization needs are also reflected by other related problems such as floods, sediment damage, impaired water quality and the impairment of natural beauty.

Range Improvement

Range improvement needs are concerned with conservation, development and utilization of the total range environment and considers the interrelationships of climate, plants, soil, water, animals and people. Past trends indicate that livestock grazing on public lands has been reduced in the 1945-1960 period about 7 percent for cattle and 25 percent for sheep. Reversal of this trend will fill a significant need in the agricultural economy.

OUTDOOR RECREATION

Visitor-days of recreation use is anticipated to reach 4,695,000 by 1985 (Table 66) compared to 1,705,000 in 1965. About 44 percent of the anticipated demand will be on National Forest lands, 19 percent on National Parks and Monuments, 5 percent on Public Domain lands and 4 percent on private lands. The remaining 28 percent is associated with State developments, municipal parks and other outdoor recreation facilities not identified.

TABLE 66.--Outdoor recreation demand, 1965 and 1985

Use areas	Visitor-days annually[a]		
	Recreation demand		Early Action needs
	1965	1985	
National Forest lands	752,000	2,066,000	1,314,000
National Parks and Monuments	328,000	892,000	564,000
Public Domain lands	85,000	235,000	150,000
Private lands	68,000	188,000	120,000
State, municipal and other	472,000	1,314,000	842,000
Total	1,705,000	4,695,000	2,990,000

[a]A visitor-day is one person per 12-hour period.

DEVELOPMENT OPPORTUNITIES AND ALTERNATIVES

The opportunities show one development alternative for the Early Action time frame relative to the long-range development potential. This provides a better understanding of the interrelationships and impacts of various types of development and provides a means for the local people to choose between alternatives.

WATER MANAGEMENT AND DISTRIBUTION

Better management and distribution, improved quality, and flood prevention are water related development opportunities. Development should be considered on the basis of feasibility, hydrologic impacts, relationship to other development measures, environmental considerations and local desires.

STORAGE

There are long-range opportunities for surface storage of irrigation water at over 20 sites with an estimated capacity of 85,000 acre-feet. In addition, one out of every two years, there is an unused capacity in the three major existing reservoirs of 150,000 acre-feet.

Investigations for the Early Action Program indicate there are feasible sites with a total storage capacity of 17,600 acre-feet of water for irrigation. The benefits and costs of the long-range irrigation water storage potential were not evaluated. Economic evaluation for Early Action development are shown below:

Total cost	$3,165,000
Annual benefits	290,000
Annual costs	178,000
Benefit-cost ratio	1.6:1

CANAL LINING

There are 1,450 miles of canals that lose water through seepage at a rate of more than 3 percent per mile, providing opportunity for water savings. The Early Action Program evaluated lining of 365 miles of canal and major laterals and installing 74 miles of pipelines. Of the total lining, 110 miles replaces parallel systems and consolidates distribution networks. About one-third of the pipelines could be used as a source of water for sprinkling systems.

The benefits and costs of canal lining and pipelines for the Early Action alternative is shown below:

Total cost	$11,438,000
Annual benefits	1,472,000
Annual costs	875,000
Benefit-cost	1.7:1

GROUNDWATER MANAGEMENT

Management of the major groundwater reservoirs probably presents the greatest potential water resource development opportunity within the Basin. The total management potential is about 550,000 acre-feet.

Potential water salvage by lowering the water table and reducing the consumptive use of water by phreatophytes is estimated at 215,000 acre-feet. About 100,000 acre-feet of this potential could be salvaged during the Early Action period.

A total of about 200,000 acres of native pasture and phreatophyte areas could ultimately be converted to more intensive cultivation downstream. Generally, the suspended sediment loads will be reduced but the concentration of dissolved solids will be increased, at least until increased temporary leaching is completed.

Sediment Storage and Land Stabilization

Opportunities exist at the 20 potential storage sites to provide sediment storage capacity of over 55,000 acre-feet. Investigations for the Early Action Program evaluated 17 sediment storage sites with a combined capacity of about 26,000 acre-feet which reduces the annual sediment load by about 310 acre-feet annually. Total sediment reduction potential through 100 percent treatment on critical areas is shown by Table 67.

TABLE 67.--Potential sediment reduction through 100 percent critical area treatment in Sevier River Basin, Utah

Land classification of critical areas	On-site erosion rate	Sediment yield at 1:5 ratio	Net reduction in sedimentation[a]
	Ac. ft.	Ac. ft.	Ac. ft.
National Forest	2,980	600	390
Public Domain	1,120	220	140
Private	210	40	30
Total	4,310	860	560

[a]Based on 65 percent effectiveness.

Critical area treatment under the Early Action Program could reduce suspended sediment 198 acre-feet. The economic evaluation for sediment storage has been combined with that for floodwater control and watershed stabilization and are discussed in following sections.

Dissolved Solids Reduction

Opportunities to improve water quality by reducing the dissolved solids concentration is limited. The Early Action Program included an off-channel evaporation basin with a capacity of 1,000 acre-feet which could remove up to 100 tons of dissolved solids per day during low flow periods. Total cost of the structure is about $436,000 with an annual benefit of $98,100, annual cost of $24,700 and a 4.0:1 benefit-cost ratio.

FLOODWATER CONTROL

Most opportunities for flood control are associated with sediment storage facilities and watershed stabilization measures. Water quality improvement is also directly related to floodwater control.

Storage

The potential for floodwater control includes storage at sites identified under discussions of irrigation and sediment. This provides a potential of 60,000 acre-feet at 20 locations.

Early Action opportunities for floodwater control were investigated at 17 sites with a capacity of 11,400 acre-feet. The economic evaluation of flood prevention structures, which includes both sediment storage and floodwater control, is shown below:

Total cost	$6,091,000
Annual benefits	423,000
Annual costs	346,000
Benefit-cost ratio	1.2:1

Channel Improvement

Channel improvement potential to increase the carrying capacity of the main stem of the Sevier River and its principal tributaries is estimated at 40 miles. In addition, about 30 miles on other tributaries could be improved.

Development during the Early Action period appeared most feasible on 3 miles of tributary drainages. Improvement of the river channel would be unnecessary if regulatory storage were installed. Total cost for channel improvement is shown on the following page.

Total cost	$28,000
Annual benefits	3,500
Annual costs	2,100
Benefit-cost ratio	1.7:1

RELATED LAND

Development opportunities to meet needs on related lands include range improvement, watershed stabilization and recreation development. Other related land development opportunities include transportation system development, timber stand improvement and reforestation, fish and wildlife habitat improvement and better protection from insect, disease and wildfire damage. Acceleration of these latter development programs may be required concurrently with the Early Action program. However, these programs were considered less amenable to the Early Action concept and were not evaluated.

Watershed Stabilization

Critical watershed areas yield 860 acre-feet of sediment. Potential reduction of sediment through 100 percent critical area stabilization is 590 acre-feet annually.

The result of watershed stabilization through the Early Action alternative is a reduction in sediment yield of 198 acre-feet annually. The economic evaluation is as follows:

Total costs	$9,711,800
Annual benefits	867,370
Annual cost	572,300
Benefit-cost ratio	1.5:1

Range Improvement

The potential range improvement opportunity was not evaluated. On National Forest lands, the potential and the Early Action evaluation opportunity are estimated to be the same due to a high rate of accomplishment in range rehabilitation through going programs and the overlap of increased forage production through watershed stabilization. The Early Action evaluation alternative is indicated by Table 68. The economic evaluation is as follows:

Total costs	$5,263,450
Annual benefits	832,770
Annual cost	391,330
Benefit-cost ratio	2.1:1

TABLE 68.--Early Action range development program, Sevier River Basin, Utah

Land classification and treatment	Unit	Amount	Net increase in grazing capacity
National Forest			
Forage production improvement	acres	225,200	
Management facilities			
Fence	miles	480	
Spring water developments	each	170	
Stock reservoirs	each	200	
	AUM[a]		45,000
Public Domain			
Forage production improvement	acres	140,700	
Management facilities			
Fence	miles	150	
Spring water development	each	40	
Wells	each	10	
Pipelines	miles	90	
	AUM		35,300
Private			
Forage production improvement	acres	29,700	
Management facilities			
Spring water development	each	60	
	AUM		6,500
Total	AUM		86,800

[a]AUM=Animal unit month, forage to support cow plus 300 pound calf for one month or 1,000 pounds of forage dry weight.

OUTDOOR RECREATION DEVELOPMENT

Potential recreation development would fully meet the long-range demands for outdoor recreation. Early Action development is proposed on National Forest, Public Domain and private lands. Tables 69, 70 and 71 indicate potential recreation development to fully meet projected demand.

The Early Action evaluation alternative will develop water surface areas of 2,500 surface acres which is more than adequate to meet boating requirements. A major portion of this development is evaluated under the irrigation water storage so it is not discussed here. To meet fishing demand, 380 surface-acres are needed

TABLE 69.--Outdoor recreation development to meet projected 1985 recreation demand on National Forest lands, Sevier River Basin, Utah

Type of development	Existing use as portion of total	Projected demand by type of development	Persons at one time (P.A.O.T.)[a]	Potential development
	Percent	Visitor-day	Number	
Water oriented				
Fishing	15	197,100	2,628	328) surface
Boating	2	26,280	350	258) acres[b]
Related land dev.				
Campgrounds	22	289,080	3,854	2,022) family
Picnic sites	2	26,280	350	200) units[c]
Resorts	2	26,280	350	
Organization site	1	13,140	175	
Rec. residences	1	13,140	175	
Roads	24	315,360	4,205	
Trails	3	39,420	263	
Observation site	1	13,140	175	
Winter sports	1	13,140	175	
Related land recreation (Undeveloped)				
Hunting	11	144,540	4,818	(30 day season)
Other	15	197,100	2,628	
Totals	100	1,314,000	20,146	

[a]Based on 150 day season times 2 to allow for peak use.

[b]Based on 1 fisherman/10' of shoreline and 20 percent of the reservoir shoreline suitable for fishing. Amount of shoreline based on 4,000'/10 surface acres. On surface, 1 boat containing 3 persons per 5 acres.

[c]Five P.A.O.T. to a family unit, 35 percent of maximum allowable capacity.

TABLE 70.--Outdoor recreation development to meet projected 1985 recreation demand on Public Domain lands, Sevier River Basin, Utah

Type of development	Estimated future use as portion of total	Projected demand by type of development	Persons at one time (P.A.O.T.)[a]	Potential development
	Percent	Visitor-day	Number	
Water oriented				
Fishing	6	9,000	120	15) surface
Boating	3	4,500	60	85) acres[b]
Related land dev.				
Campgrounds	11	16,500	220	125 family units[c]
Observation sites	9	13,500	180	
Roads	39	58,500	780	
Other	3	4,500	60	
Related land recreation (Undeveloped)				
Hunting	11	16,500	1,100	(30 day season)
Other	18	27,000	360	
Totals	100	150,000	2,880	

[a]Based on 150 day season times 2 to allow for peak use periods.

[b]Based on 1 fisherman/10' of shoreline and 20 percent of the reservoir shoreline suitable for fishing. Amount of shoreline based on 4,000' for 10 surface acres. On surface, 1 boat containing 3 persons per 5 acres.

[c]Five P.A.O.T. to a family unit, 35 percent of maximum allowable capacity.

TABLE 71.-- Outdoor recreation development to meet projected 1985 recreation demand on private lands, Sevier River Basin, Utah

Type of development	Estimated future use as portion of total	Projected demand by type of development	Persons at one time (P.A.O.T.)[a]	Potential development
	Percent	Visitor-day	Number	
Water oriented				
Fishing	19	22,800	304	38) surface
Boating	5	6,000	80	90) acres[b]
Related land dev.				
Campgrounds	4	4,800	64	36 family units[c]
Vacation farms	6	7,200	96	
Roads	6	7,200	96	
Riding stable	2	2,400	32	32 horses
Resorts	3	3,600	48	
Rec. residences	27	32,400	432	86 summer homes[d]
Related land rec. (Undeveloped)				
Hunting	26	31,200	2,080	(30 day season)
Other	2	2,400	32	
Totals	100	120,000	3,264	

[a]Based on 150 day season times 2 for peak use period.

[b]Based on 1 fisherman/10' of shoreline and 20 percent of the reservoir suitable for fishing. Amount of shoreline based on 4,000'/10 surface acres. On surface, 1 boat containing 3 persons per 5 acres.

[c]Five P.A.O.T. to a family unit, 35 percent of maximum allowable capacity.

[d]Five P.A.O.T. per summer home.

and 375 surface-acres are planned in conservation pools. The economic evaluation for the recreation pools discussed is shown below:

Total cost	$1,706,000
Annual benefit	222,000
Annual cost	115,000
Benefit-cost ratio	1.9:1

The Early Action alternative will meet 1985 outdoor recreation demands for fishing, boating and campground development or about 49 percent of the total recreation development needs.

Installation costs for campground development are $4,888,000 on National Forest land to provide annual benefits of $568,000 and $275,000 on Public Domain land to provide annual benefits of $31,800. Benefit-cost relationships for campground developments are:

Total cost	$5,163,000
Annual benefit	600,000
Annual cost	384,000
Benefit-cost ratio	1.6:1

ALTERNATIVES

To accomplish the desires of the local people, alternative developments could be implemented at different levels of intensity and segments. A number of alternatives are possible but physical and economic feasibility could reduce these to relatively few combinations.

Irrigation Water Management and Distribution

Alternate sites with a total capacity of 31,900 acre-feet could be developed in combination with the three major existing reservoirs with an average unused storage of 150,000 acre-feet to provide irrigation water storage. The existing reservoirs, however, are not located where they can deliver water to all areas where a shortage exists. The groundwater reservoirs with a management capacity of 550,000 acre-feet could provide an alternative storage capability. Canal lining, irrigation water distribution system reorganization and on-farm improvement practices can supplement or replace surface water and groundwater storage and management.

Water salvage values shown in the preceding sections are a conservative estimate of the feasible salvage from structural and on-farm developments and groundwater management. An alternative set of water-budgets used more optimistic values for water salvage with similar development measures.

Table 72 shows the increase in gross salvage and net salvage by sub-basin with the corresponding change in outflow. The increase in water salvage would require a greater reduction in consumptive use on wetlands from lowering the water table. The inflow to Sub-basin B would be increased 21,760 acre-feet over present conditions as compared with 6,920 acre-feet for the Early Action alternative.

With increased inflow into Sub-basin B, the required groundwater management could be reduced from 82,000 acre-feet to approximately 70,000 acre-feet. Well costs could be reduced by 15 percent.

TABLE 72.--Alternative water salvage by sub-basin, Early Action Program, Sevier River Basin, Utah

Sub-basin	Consumptive use deficit satisfied	Gross	Net[a]	Change in outflow[b]
	Ac. ft.	Ac. ft.	Ac. ft.	Ac. ft.
F	- -	4,810	840	- 2,660
E	500	8,700	2,170	+ 2,240
D	8,390	21,720	3,700	+ 3,230
A	13,750	26,860	19,740	+12,040
C	9,090	32,850	6,130	- 2,440
B	43,640	38,950	38,950[c]	+10,540
Total	75,370	133,890	71,530	

[a]Value is equal to gross salvage minus consumptive use on converted lands.

[b]Change as generated by development measures within the sub-basin.

[c]No converted lands in Sub-basin B.

Water Quality Improvement

The quality of water can be improved through sediment storage, watershed land treatment, erosion control, chemical and bacteriological pollution control measures and on-farm development practices. Sediment storage may be the only solution in some areas where watershed land treatment is prohibitive in cost or is limited by the physical characteristics. In other areas, land treatment measures may be adequate without structural development protection. Generally, combinbations of several types of treatment and structures is necessary to accomplish the desired protection.

Reduction of pollution caused by dissolved solids and chemical and bacteriological contaminants is more difficult to control and alternatives are limited. Other sites for evaporation basins than the one described for Lost Creek may be feasible for reducing pollution from dissolved solids. Another alternative would be to provide by-pass canals around areas of Arapien shale. Also, release of storage water during low-flow periods will reduce the high concentration of dissolved solids even though the total load remains the same.

Bacteriological and chemical pollution control will depend on proper use and disposal of fertilizers, herbicides and pesticides, feedlot drainage and sewage.

Flood Control

Protection from floods is usually best accomplished with a combination of structures and watershed stabilization. Downstream structural measures including reservoir storage, by-pass structures and channelization are desirable where recurring floods damage cultural developments.

Watershed Stabilization

The principle objective of watershed stabilization is maintenance and enhancement of on-site productivity. Off-site structural measures are not an alternative to meet this need.

There is an infinite number of levels and intensities in critical area treatment. Alternatives are also implicit in types of treatment. Emphasis in some areas should be placed on stream channel stabilization while other areas may lend themselves to more intensive sheet erosion control

Range Improvement

Alternative sources of livestock feed requirements include land use conversion to irrigated pastures from phreatophytes and croplands. Feedlot operations are also an alternative.

Intensive range management, such as rest rotation systems, may offset some of the need for forage production improvement. Proper intensive management is essential to both protect the investment in range restoration and to maintain range productivity.

Outdoor Recreation

Larger conservation pools should be considered for reservoirs in scenic settings and supporting cold water fishing. Alternative levels of outdoor recreation development as well as the alternative need for specific types of development is implicit in previous

data. Detailed study may indicate that other types of outdoor recreation development are needed and should be emphasized in place of those shown.

Greater emphasis will likely need to be placed on private development related to tourist services and facilities. This aspect of recreation activity was not investigated.